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MACHINE LEARNING TECHNIQUES TO RECOMMEND PRODUCTS IN E-COMMERCE: A SYSTEMATIC REVIEW

Md Hesam Akhter*, Vinod Kumar Panchal**

Abstract: *Product recommender systems have been an effective approach to overcoming information overload on the Web, with the growing size of online statistics, as recommending the right product based on consumer liking became challenging for e-commerce businesses. The machine learning techniques can be applied to solve it. However, due to the large number of algorithms available in the literature, it is quite difficult to select a suitable machine learning algorithm. Researchers have little information about the best approaches to develop recommender systems for e-commerce using machine learning. Here, we have presented our work as a systematic review of the literature, which surveys to choose machine learning algorithms to recommend products in e-commerce and recognise research opportunities for the researchers in developing recommender systems. The survey concluded that deep learning and neural networks techniques are widely used to predict the right products for recommendation to the customers in e-commerce, because they can be very good at recognising patterns in a way similar to the human brain.*

Keywords: *Machine Learning, Product Recommendation, E-Commerce, Systematic Review*

INTRODUCTION

In e-commerce, recommending products on the basis of customer preferences is widely used. It provides information related to the users' interest or their searching query. The information extracted from users' preferences or the pattern of their previously searched query can be used for the relevant prediction for the customers (Tewari, Kumar & Barman, 2014). However, it is not possible to think about every product to recommend to the customers in e-commerce, as there are a huge number of products available. So, the product recommender system is the effective strategy to recommend the product on the basis of customer likings (Felden & Chamoni, 2007).

There are machine learning techniques to know the purchasing patterns of the customers and identify the problem to find the right customers to recommend products, and then analyse the market. Machine learning techniques are very useful and have a huge impact on identifying the behaviour of customers, to recommend the right product based on similarities between users and items simultaneously (Columbus, 2018). It requires the study of the characteristics of customer behaviour and their interests, and handle customers' interactions data for enhancing business module. Therefore, it is important to evaluate the machine learning algorithms to develop recommender systems to recommend relevant products to the customers in e-commerce. There are numerous machine learning algorithms to recommend products, described in the literature (Kulkarni, 2012). Here our work has been presented as a survey of the literature that analyses the use of machine learning algorithms to recommend products in e-commerce. The paper concluded that deep learning and neural networks techniques, or deep neural network, are broadly used to predict the relevant products for recommendation to the customers.

BACKGROUND

Machine Learning

Machine learning is a subfield of AI (Artificial Intelligence) that enables machines to automatically learn and improve with experience, without being explicitly programmed (Columbus, 2018). That means, machine learning is the technique to analyse data and learn to predict results.

There are numerous machine learning algorithms suggested in literature, and they can be categorised based on the approaches applied to learn processes. There are three major categories: *supervised, unsupervised, and reinforcement learning* (Adebola & Bukola, 2019).

In *supervised learning*, we use data that has already been labelled to train the machine. This indicates that the data

* Al-Falah University, Haryana, India. Email: hesam@kashmiruniversity.ac.in
**Al-Falah University, Haryana, India.

has been tagged with the correct response. The machine is then given a new piece of data to evaluate and produce an outcome from the labelled data (Adebola & Bukola, 2019).

The algorithm in *unsupervised learning* is not given pre-assigned labels for the training data. That is, the algorithm is allowed to perform independently of anyone's supervision, allowing the model to uncover hidden patterns to make predictions about the output (Adebola & Bukola, 2019).

Reinforcement learning is the process of establishing a pattern of behaviour by using the hit-or-miss approach, as the only way to learn is through experience and then learning from experience. In this technique of learning, an agent interacts with the environment by performing actions and discovering errors or rewards; once trained, the agent is able to predict new data (Kulkarni, 2012).

Machine learning is divided into five phases: *data collection, data preparation, training a model, testing the model, and improvement.*

The first phase in the machine learning process is *data collection*, which varies depending on the project and data type. Then *data preparation* comprises removing duplicates, dealing with missing values, correcting errors, and converting data types, among other things. In *training a model*, we must train the datasets on some mathematical model to learn and develop predictions. After training a model, to ensure that the model is accurate, it must be validated in *testing a model*. If the results are not satisfactory, the model needs to be improved and retrained. Finally, a model's accuracy can be improved by attempting a different method or modifying the algorithm's parameters in the *improvement* phase (Marović et al., 2011).

Product Recommendations in E-Commerce

Recommending products in e-commerce is a particularly specific type of machine learning system. They are not some sort of all-purpose algorithm that can provide a solution to any given problem. However, systems that just recommend values for arbitrary tasks, which is what machine learning is all about, are not actually recommender systems. For example, suppose we are looking for a system that suggests prices for a home, based on its size, closeness to other homes, and other factors. That is a machine learning system, not a recommender system (Marović et al., 2011).

So, a recommender system, in greater detail, is a system that analyses a user's rating or preference for an item. As a result, a recommender system recommends items to people based on their previous behaviour and the behaviour of others (Marović et al., 2011).

Basically, it analyses customer data on each user's likes and dislikes (cookies allow for multi-visit tracking), then provides suggestions based on that user's browsing behaviour. The concept is that if we like something, we will probably like something similar. For instance, suppose we were looking for some electronic gadgets and continually liked them, the filtering algorithm would take that information and start suggesting similar items based on our preferences (Wei et al., 2008).

Another filtering strategy incorporates data from customers who have purchased comparable products, and then combines that knowledge to produce suggestions. This filtering method has the advantage of being able to make complicated recommendations on items like music or movies without having to understand what they are. This filtering strategy is based on the idea that customers will prefer recommendations that are based on previous purchases (Wei et al., 2008). Here is an an illustration: If customer A enjoys a particular line of items that customer B enjoys as well (assuming they share similar interests), the filtering technique will assume that customer A will enjoy similar products purchased by customer B and vice-versa.

The type of recommendation strategy given is completely dependent on the product category. High-value products, such as electronics, profit from display advertisements that encourage visitors to spend more time on the website during their decision-making process (Wei et al., 2008).

If we go to amazon.com, we will notice a number of widgets that recommend purchases based on other things we have looked at or engaged with in the past, as well as information from all of Amazon's other customers. So, a recommender system is attempting to make suggestions to us.

It is not necessary for the items to be physical. It could also be content. It could be in the form of music or videos. So, if we go to Netflix, they are recommending movies to us based on our previous browsing history and the online activity of others (Marović et al., 2011).

Customers appreciate shopping experiences that allow them to come across inspiring and surprising bargains without having to search through every category and product page. There is a recommendation engine that assists us with this on the online stores, by continuously finding and presenting the most valuable products (Marović et al., 2011).

SYSTEMATIC REVIEW

The decision to choose machine learning algorithms from several different ones, to be utilised by the researchers to develop a system of recommending products in e-commerce has a significant impact on the explanation, the data that

will be required from users and suggestion items, and performance constrains. The large number of algorithm modifications and combinations in literature makes this a difficult decision.

Since the subject of machine learning research is always evolving, fresh studies must be conducted to identify new open challenges and trends, as well as to further improve the field's knowledge base. So, we decided to conduct a systematic review to assess the evolution of a system to recommend products in e-commerce with machine learning algorithms and draw conclusions. The objective of this review is to identify the machine learning algorithms used to recommend products and find out the suitable one to provide the best and relevant results.

For this, the following study has been made and presented with an explanation.

Recommender systems try to anticipate users' interests and suggest items that are likely to be of interest to them. By installing recommender systems on their websites, e-commerce enterprises are utilising the power of data and improving sales (Felden & Chamoni, 2007).

The first recommender system, Tapestry, was developed in 1992, and employed *collaborative filtering* to refer to the recommendation (Felden & Chamoni, 2007).

Recommender systems are classified as *collaborative, content-based, or hybrid filtering*, based on the information provided for recommendation (Canny, 2002). Recommender systems that use collaborative filtering take user data into account while making product recommendations. The recommender system can identify a user, share the same product, and then suggest products bought by similar users by accessing user profiles in an online store. By accessing user data such as age, gender, location, and product purchased, the recommender system can detect the user, share the same product, and then recommend the product purchased by similar users (Tewari, Kumar & Barman, 2014).

The research is aimed at recommender systems that use machine learning methods and have been implemented and tested with real or simulated data. As machine learning models human learning by allowing computers to recognise knowledge from the actual world and enhance performance on specific tasks using that knowledge, machine learning algorithms are commonly employed in recommending products in e-commerce and businesses (Kulkarni, 2012).

Machine learning algorithms are also implemented in movie ratings prediction to recommend movies to the relevant users on Netflix, Amazon Prime Video, or other OTT (Over-the-Top) platforms. For this, the commonly used algorithms are *Naïve Bayes* and *K-Mean Clustering.*

Naïve Bayes: It is based on the Bayes theorem and leverages prior data knowledge. It calculates the classification probability to enable in resolving the model's uncertainty (Marović et al., 2011). For example, if,

Input: users *X*, movies *m*, rating *r*, number of movies to be recommended *(μ)*.

Output: Recommended movies *R*.

K-Mean Clustering: The items are distributed into k clusters based on their similarity in this approach. Euclidean distance is used to determine how near they are. Each cluster has a centroid, which is the average of all the objects. Moving objects towards the centroid updates the centroid. It continues until the saturation point is reached, leading to a reduction in computing complexity (Marović et al., 2011). For example, if,

Input: users *X*, movies *m*, rating *r*, number of movies to be recommended μ, value of *k*.

Output: Recommended movie *R*.

Besides the above algorithms, *deep neural network* can also be used to predict products for recommendations. Deep neural network is basically deep learning with the neural network of AI (Artificial Intelligence) (Kim & Ahn, 2009). Deep learning is a sort of machine learning that is inspired by the human brain's structure. This structure is known as an artificial neural network in deep learning (Bai et al., 2017).

Deep learning and artificial neural networks can be applied in recommender systems. Deep learning allows the neural network to pick out features without the need for human involvement; however, this independence comes at the cost of a significantly larger amount of data with which to train our system (Bai et al., 2017).

REVIEW RESULTS

The goal of this survey was to find information about machine learning algorithms implemented to recommend products in e-commerce. We analysed the data after reading literature on this subject, and observed that recommender systems are classified as *collaborative, content-based, or hybrid filtering*, based on the information provided for recommendation. Initially, collaborative filtering was employed to refer to the recommendations that takes user data into account while making product recommendations.

It has been observed that the algorithms Naïve Bayes and K-Mean Clustering are widely used in implementing movie ratings prediction to recommend movies or other entertainment shows to the relevant users on OTT (Over-the-Top) platforms (Eichinger, 2006).

Movies are the most popular domain, with numerous publications. The ease of access to data in the movie domain is one reason for this result. To recommend products, *Bayesian* techniques are more commonly employed as the algorithm. The reduced complexity of Bayesian calculations, we believe, is responsible for this finding. The usage of *decision trees* as the second most common strategy for machine learning algorithms in recommender systems may be validated by the same explanation. Both Bayesian and decision tree techniques use similar computations and have gained popularity in recent years (Fullerton, 2013).

Deep neural networks are also popular, and their application in image recognition and self-driving cars and categorisation appears promising (Bai et al., 2017). Although neural network approaches have been identified in a number of articles, there is still much more work to be done in terms of applying these algorithms to recommend products to users. One explanation for the limited adoption of neural networks in the recommender systems sector is that researchers are still trying to figure out why some neural networks make specific decisions. This method's understanding is currently being researched.

While reading the papers for this systematic review, we noticed that some of them used mathematical or statistical methods to describe the machine learning algorithms. Calculations, such as the *least squares*, *cosine measure*, and *Pearson correlation* are examples of mathematical or statistical approaches (Lucas, Segrera & Moreno, 2012). Since machine learning algorithms employ them to build parameters that assist in recommendation, they were included individually. As the machine learning research field has its origins in these fields, it is predicted that a large number of papers would describe a mathematical or statistical method.

CONCLUSION

We gathered roughly 21 publications for this review. After we finished reading all of the research articles, we concluded the following. The collaborative and content-based filtering are commonly used techniques in recommending products in e-commerce. K-Mean is one of the simplest machine learning algorithms used in the recommender system with Naïve Bayes. However, in most cases, Bayesian or a decision tree techniques are used due to their popularity; the simplicity in calculations and implementation contribute to the result. Additionally, because the machine learning area has its roots in mathematics and statistics, most of the techniques contain a mathematical or statistical representation of algorithms.

REFERENCES

Felden, C., & Chamoni, P. (2007, January). Recommender systems based on an active data warehouse with text documents. In *System Sciences,* 2007. HICSS 2007. 40th Annual Hawaii International Conference on (pp. 168a-168a), IEEE.

Tewari, A. S., Kumar, A., & Barman, A. G. (2014). Recommendation system based on combine features of content based filtering, collaborative filtering and association rule mining. *IEEE* (pp. 500-503).

Maheswari, K., & Priya, P. (2017). Predicting customer behavior in online shopping using SVM classifier. In *IEEE International Conference on Intelligent Techniques in Control, Optimization and Signal Processing* (p. 5), IEEE.

Columbus, L. (2018, December). 10 ways machine learning is revolutionizing sales. *Enterprise and Cloud,* p. 10.

Kulkarni, S. (Ed.) (2012). Machine learning algorithms for problem solving in computational applications, intelligent techniques. *IGI Global.*

Murali, M. V., Vishnu, T. G., & Victor, N. (2019). *A collaborative filtering based recommender system for suggesting new trends in any domain of research*. In International Conference on Advanced Computing & Communication System (ICACCS).

Bellogín, A., Castells, P., & Cantador, I. (2011). Precision-oriented evaluation of recommender systems: An algorithmic comparison. *ACM,* 978-1-4503-0683-6.

Marović, M., Mihoković, M., Mikša, M., Pribil, S., & Tus, A. (2011). Automatic movie ratings prediction using machine learning. *MIPRO, Proceedings of the 34th International Convention* (pp. 1640-1645), IEEE.

Wei, C. P., Yang, C. S., & Hsiao, H. W. (2008). A collaborative filtering-based approach to personalized document clustering. *Decision Supp. Syst., 45*(3).

Adebola, O., & Bukola, O. (2019). Predicting consumer behavior in digital market: A machine learning approach. *International Journal of Innovative Research in Science, Engineering and Technology, 8*(8).

Kim, J., & Ahn, H. (2009). A new perspective for neural networks: Application to a marketing management problem. *Journal of Information Science and Engineering, 25,* 1605-1616.

Canny, J. (2002). Collaborative filtering with privacy via factor analysis. *Proceedings of the 25th Annual International ACM SIGIR Conference on Research and Development in Information Retrieval* (pp. 238-245). Finland, Tampere: ACM Press.

Bai, B., Fan, Y., Tan, W., & Zhang, J. (2017). A deep learning framework for recommendation of long-tail web services. In *IEEE Transactions on Services Computing,* 2017.

Bujang, M. A., Sa'at, N., & Sidik, T. M. I. T. A. B. (2017). Determination of minimum sample size requirement for multiple linear regression and analysis of covari-

ance based on experimental and non-experimental studies. *Epidemiology Biostatistics and Public Health, 14*(3).

Khade, A. A. (2016). Performing customer behavior analysis using big data analytics. In *7th International Conference on Communication, Computing and Virtualization* (p. 7), Science Direct.

Alasadi, S. (2017). Review of data preprocessing techniques in data mining. *Journal of Engineering and Applied Sciences, 12*(16), 4102-4107.

Eichinger, F., Nauck, D., & Klawonn, F. (2006). Sequence mining for customer behavior predictions in telecommunications for marketing in a digital era. *European Management Journal, 32*(1), 112.

Fullerton, R. A. (2013). The birth of consumer behavior: Motivation research in the 1950s. *Journal of Historical Research in Marketing, 5*(2), 212-222.

Ericson, K., & Pallickara, S. (213). On the performance of high dimensional data clustering and classification algorithms. *Future Generation Computer Systems, 29*(4), 1024-1034.

Egghe, L., & Leydesdorff, L. (2009). The relation between Pearson's correlation coefficient r and Salton's cosine measure. *Journal of the American Society for Information Science and Technology, 60*(5), 1027-1036.

Lucas, J. P., Segrera, S., & Moreno, M. N. (2012). Making use of associative classifiers in order to alleviate typical drawbacks in recommender systems. *Expert Systems with Applications, 39*(1), 1273-1283.