

MACHINE LEARNING BASED PRODUCT RECOMMENDATION SYSTEM IN E-COMMERCE

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ABSTRACT

E-commerce websites and applications have been in use since a long time but the rate at which they are being used nowadays especially after the COVID-19 pandemic has increased rapidly where every single person is dependent on the internet and majorly e-commerce sites and applications to get their daily needs delivered at their doorstep. As there are multiple options available to select from, sometimes it becomes difficult for the user to find suitable products. Here comes the role of recommendation systems which recommend the best and appropriate content to the user based on their choices, exploration history, etc.

This paper presents a review on product recommendation systems based on machine learning techniques where machine learning is a subcategory of artificial intelligence and consists of algorithms which learn insights and recognize patterns from data thereby applying that learning to help make better decisions.

KEYWORDS: Machine learning, Product recommendation, E-commerce

1. INTRODUCTION

In the modern digital world, E-Commerce happens to be a boon for everyone where a variety of things can be explored and purchased in a single click. However, with an increase in the number of options to choose from, information overload is one of the setbacks to users. In order to solve this problem, recommendation systems have been developed to help users filter and prioritise relevant information thus reducing time and providing hassle free experience to users. Recommendation systems have become an integral part of E-Commerce platforms (Schafer et.al., 1999). These recommendation systems use customer opinions, browsing patterns and experiences to give personalised suggestions to the customer. These systems help the companies to retain customers by providing a better user experience. To design automated and intelligent applications known as recommendation systems, knowledge of machine learning is required. Different machine learning algorithms are used to develop these systems. Following sections include an introduction to machine learning, product recommendation system and a literature review on techniques and algorithms used to develop better recommendation systems.

2. MACHINE LEARNING

Machine learning is a subset of Artificial Intelligence which provides the machines the ability to automatically learn and improve from experience without being explicitly programmed to do so. (Expert.ai team, 2022)

2.1 TYPES OF MACHINE LEARNING

Supervised Learning: Supervised learning makes use of labelled data sets in order to train the algorithms to help them classify data or predict outcomes accurately. These methods predict the outcome/future (Singh, N., 2022). Methods like neural networks, naïve bayes, linear regression, logistic regression, random forest, and support vector machine (SVM) use supervised learning.



Fig 2.1: Supervised learning model

Unsupervised Learning: In unsupervised learning, models are trained using unlabelled data. These models find hidden patterns or structures in data sets and group them according to their similarities. Principal component analysis (PCA), singular value decomposition (SVD), k-means clustering, and probabilistic clustering methods are examples of unsupervised learning algorithms.



Fig 2.2: Unsupervised learning model

Reinforcement Learning: Reinforcement learning is a reward-based learning where the model learns by trial-and-error method and is given a reward which can be positive or negative. Markov Decision process, Brute Force are examples of reinforcement learning algorithms. (Singh, N., 2022)

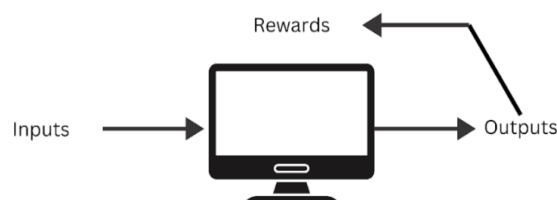


Fig 2.3: Reinforcement learning model

3. LITERATURE REVIEW

Dutta, R. and Mukhopadhyay, D. (2011) introduced item frequency in weighted cosine similarity measure in e-commerce area, where results showed that there was a slight improvement in performance of the system. More than one product was recommended using association rule which improved the 'recall' performance measure used in recommending the products. This paper also solved the sequence recognition problem by finite state machine which gave an acceptable result in making recommendations for a new user.

Regi, N. A. and Sandra, P.R. (2013) presented a comprehensive review on various algorithms used to build a recommendation system for e-commerce platforms. This included a study on item based collaborative filtering algorithms, integration of content based and collaborative

filters, association rule mining, decision tree induction. It was concluded that different algorithms should be used in different scenarios.

Singh, M.K. (2021) proposed a knowledge-based collaborative filtering algorithm for a large data set that used various activities done by users during interaction of items through E-commerce web sites like clicks, select and purchase. This filter processed the unstructured heterogeneous information into a structured form by using the concept of knowledge graph. The performance of the system was compared with the base models using real time Amazon E-commerce dataset using precision, recall and NDCG evaluation parameters in various combinations of activities performed by users on items. It was concluded that the performance of the proposed filter was much better than the other filters used in recommendation systems.

Farooq., R.A., et al. (2022) suggested that Hybrid systems were more suitable for e-commerce applications while in general, content-based systems were more suitable when data set was small. For large data sets, collaborative systems were suitable for recommendation.

J. Anitha and M. Kalaiarasu (2022) developed a recommendation system in two stages which included a (1) Support Vector Machine classifier for classifying the entities into positive and negative feedback and (2) then a collaborative filtering algorithm was developed using support Vector Machine-Improved Ant Colony Optimization. Tests on Taobao data (an Alibaba owned Chinese online shopping website) were conducted. It was concluded that collaborative filtering-based recommendation systems provided superior recommendation accuracy thereby commanding a particular predominant place in the e-commerce field.

Liu, L. (2022) analyzed user-based recommendation systems, collaborative filtering recommender systems and content-based recommender systems and proposed a Structural Equation model, a recommendation system that combines three recommendation algorithms. Experiments were conducted on it. The results signified that customer income level, customer online shopping experience, commodity prices, product quality, recommendation relevance, credit evaluation, and service quality had a significant positive impact on shopping willingness and ultimately affected the customer's shopping behavior.

Loukili, M., et al. (2023) used association rules via Frequent-Pattern-Growth algorithm to provide personal recommendations to customers. This method provided better results where the probability of purchasing the next product suggested by the recommendation system was found to be very high.

4. PRODUCT RECOMMENDATION SYSTEMS

In recent years, recommendation systems have become so popular that they are used in a variety of areas like music, books, clothes, movies, etc. These systems are basically filtering systems that analyze the data sets and provide recommendations to the customer based upon their history, likes, clicks etc. Majority of the recommendation systems are used in e-commerce sites and applications.

Following are a few factors that specify the need for development of Product Recommendation Systems (Pajorska, Z. 2023)

1. **Customer satisfaction:** These systems work according to the user preferences, hence giving them immense satisfaction while purchasing products.
2. **Revenue Boost:** These systems help in revenue growth as E-commerce businesses are able to retain their customers by providing them the best user experience.

3. **Reduced workload:** These systems are automated and therefore require less human intervention thereby reducing their workload.
4. **Controlled Retailing:** They help in strategically guiding customers to purchase particular products.

4.1 DIFFERENT TYPES OF CONNECTIONS IN PRODUCT RECOMMENDATION SYSTEMS-

1. **User-product relationships** –These are based on the user's individual product preferences.
2. **User-user relationships** – These are based on similar types of people having similar product preferences.(Mrukwa, G. 2023)
3. **Product-product relationships** – These are based on products that can be categorised into relevant groups.

4.2 TYPE OF DATA USED IN RECOMMENDATION SYSTEMS-

1. **Explicit data:**It is in the form of numbers, e.g. ratings given to a product.
2. **Implicit data:** It deals with how the user interacts with a particular product. e.g. number of times a product is reviewed or added to cart, etc.
3. **Item attributes:** This includes product description, categories, etc.

5. CHALLENGES IN DEVELOPING PRODUCT RECOMMENDATION SYSTEMS-

1. **Cold Start:** Whenever a new customer uses an E-Commerce platform, the system has no information about their history, preferences and hence cannot recommend products to the customer. Another type of problem is when new products are added which have no review or likes among other users, no recommendations can be made. This is called the cold start problem.
2. **Accuracy:** Recommendation systems should be able to accurately predict the preferences of the user.
3. **Data Sparsity:** Sometimes users do not rate the items or rate only few out of many available items, hence this creates a problem in identifying a similar type of user or item.
4. **Inability to capture changes in user behavior**
5. **Privacy concerns:** Many customers do not provide their personal information and without this data, the recommendation engine cannot function effectively.
6. **Investment:** Investment not only in terms of finances but in terms of time too is required to develop an effective recommendation system.

5.1 PROCESS OF BUILDING A RECOMMENDATION SYSTEM USING MACHINE LEARNING-

1. **Data collection and Preparation:** This phase includes collection of explicit, implicit and descriptive data from databases, APIs or web scrapping followed by data processing. Data processing further includes data normalization and categorization where data normalization is the process of transforming data onto a common scale which was originally in different format or scales. (Krysiak, A, 2023)

2. **Implementing recommendation algorithm:** Choosing the right algorithm is key to a successful recommendation system.

6. VARIOUS RECOMMENDATION SYSTEM ALGORITHMS ARE-

1. **Content Based Filtering:** Content-based filtering uses machine learning algorithms to predict and recommend new but similar items to the user. Recommendations are based on user history like clicks, ratings, user profile. (Techlabs, M. 2017)
2. **Collaborative Filtering:** In collaborative filtering, similar users with similar tastes are grouped together and target users are recommended products on the basis of the preferences of these other users. This does not ensure precise recommendations as people with similar taste may not like similar products.
3. **Memory-based:** This relies solely on the user-item interaction matrix and mathematical calculations are used to find nearest neighbors and suggest new items.(Turing)
4. **Model based:** An underlying model is used to presuppose the interactions where the model is later tuned and items are ranked according to this model. Items with a higher compatibility score are recommended to the user.
5. **Knowledge Based Filtering:** Knowledge-based recommenders exploit semantic user preference knowledge, item knowledge, and recommendation knowledge, to identify user-relevant items which are of specific relevance when dealing with complex and high-involvement items. Such recommendations are primarily applied in scenarios where users specify (and revise) their preferences, and related recommendations are determined on the basis of constraints or attribute-level similarity metrics.
6. **Hybrid filtering:** It is a combination of various filtering techniques. In this technique similar items are suggested to the user which are already used by the user or are more likely to be used in future.
7. **Developing recommendation model:** The data is fed into the algorithms and models are allowed to learn from data patterns and user preferences. Recommendation models are evaluated on the basis of precision, recall, mean square error, A/B testing.
8. **Integration and Deployment:** The developed model is embedded into an existing application or platform and it is ensured that the model works efficiently.

7. CONCLUSION

Recommendation systems have been in use for a long time now. The best use of these systems has been in the e-commerce industry where the users get personalised suggestions for various products based on their previous choices and purchase history. This helps users explore a wide range of products in a better way. The E-commerce industry has been developing different machine learning algorithms and even improving the existing recommendation systems using different algorithms to provide better recommendations to the user.

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