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# Improved Product Ranking For Recommendation Systems

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***Abstract:*** In the new area of information technology, the most important and recognition machine learning technique is Recommender engine. Vast numbers of knowledge discovery techniques are applied by recommender system to the problem of making personalized recommendation for product, information and services during a live interaction [5]. The users which have no sufficient ability to evaluate the, potentially overwhelming, numbers of alternatives, at that time a recommender system is very helpful to those users. Recommender systems provide a personalized and items which are included in ranked list by predicting what the most suitable items are, based on the user's history, preferences and constraints [2]. RS are k –nearest item based collaborative filtering approach. They are obtaining on web which is intelligent. Vast amount of information is available on the web and many visitors which are visit the website that possess the challenges for recommender systems in recent years. The challenges are: They generate high quality recommendations, accomplish lots of recommendations per second for millions of users and items and achieving high data sparsity [5]. The Recommendation Engine Provides the functionality to Ecommerce portal. Where the items are added to shopping cart and similar items are recommended to the user based on their purchase patterns. Recommendation Engine will analyze huge Data sets of User purchase pattern and recommend items to online users based on Machine Learning Algorithms.

***Keyword:*** Recommender System, Evaluate, Data Sparsity

## I. Introduction

The main purpose of a recommendation engine is to make inferences on existing data to show relationships between objects. Objects can be many things, including users, items and products. Relationships provide a degree of likeness or belonging between objects. The intended purpose of recommendation engines is to suggest to user's objects or information which might interest them. It is useful for personalizing our web application. Recommendation system has also most important goal is to help the users to find the data or information, which is according to the preferences of users [4]. Nowadays the internet is utilized by most of users and they can purchase the items by making an order online. Today online resources are rapidly grow. So it is quietly hard for users to find the information, when users have need. For this purpose, personalized recommendation system is widely used [3]. The intention of choosing the collaborative filtering technology in recommendation system that it is a potent technology, which predict the user's preferences through the user's past opinions [1]. It is most representative system for personalize recommendation in E-commerce on web [4].

Recommender systems are a subclass of information filtering system that search to predict the 'rating' or 'preference' that user would give to an item. Three methods are useful in designing to design recommendation method.

1) Content based method and
2) Collaborative filtering method
3) Hybrid recommendation method

Some basic mechanism of algorithm and introduction of new methods have been used in commercial products.

**Content based method: -** As the name of this method suggest that to retrieve features from the content of item, sometimes they are words which describe the item. Pandora may be using content based method for commercial product. Pandora is a music recommendation system and it used a very little information to get started. All features are scored by human-beings.

**Collaborative filtering method: -** The main important method in recommendation system is collaborative filtering methods that search a group of people that share the same or similar interest with you. These people could be determined easily by the same ranking on items. The Neighborhood of the current user are called by these people. If many people in this neighborhood liked an item, then current user also liked that item. Example of this method is Netflix. A recommendation system involves rating on item by using this method. Another kind of CF method is called item-to-item collaborative filtering method.
They are depicted below.

- Memory based CF,
- Model based CF.

**Hybrid recommendation method**: - It is combination of content based filtering and collaborative filtering approach. The content filtering is based on relationship between content or descriptions. While collaborative filtering is based on user's preference and the similarity with active user [9]. It adopts nearest neighbor algorithm, so calculate distance between the users according to users 'preference and find out target user's nearest neighbor. The recommendation system recommends resources to user in a personalized way and this system helps users find out the needed resources.

**Various approaches to recommendation system: -** The Recommendation Engine Provides the functionality to Ecommerce portal. Where, the items are added to shopping cart and similar items recommended to the user based on their purchase patterns. Recommendation Engine will analyze huge Data sets of User purchase pattern and recommends items to online users based on Machine Learning Algorithms. Product Recommendation based of following consideration:

- **User Behavior**- It is also called as Generation recommendation: Whenever any user selects an item, any related item or most recommend item given to user, which are chosen by most of the user.
- **User Similarity:** To search similar users which recommend items is known as user similarity. This is quite difficult because of the nature of user is change day to day.
- **Item Similarity:** It has an ability to calculate similarity between items and prepare recommendations. Items are static, so computation offline is preferable for item similarity.

To calculate the similarity between two items, there are different mathematical formulations that can be used.

**Cosine-based similarity**: – To rate the item in form of vector. If some items aren't rated by users, the score of rating is considered as zero. To compute the cosine of the angle between the two vectors generate similarity between two items. The ratings of $i^{th}$ item and $j^{th}$ item in m dimensional user space can be expressed as i and j, similarity between i and j can be given as the following formula:

$$sim(i,j) = \cos(\vec{i},\vec{j}) = \frac{\vec{i}\,\vec{j}}{\|\vec{i}\| \times \|\vec{j}\|}$$

**Pearson similarity: –** Both items i and j are rated by users and set the all users Uij who both rated items i and j. It is also known as Correlation similarity between i and j can be computed as the following formula:

$$p_{ij} = \frac{\sum_{u \in S_{i,j}(\tau)} (r_{ui} - \overline{r_i})(r_{uj} - \overline{r_j})}{\sqrt{\sum_{u \in S_{i,j}(\tau)} (r_{ui} - \overline{r_i})^2} \sqrt{\sum_{u \in S_{i,j}(\tau)} (r_{uj} - \overline{r_j})^2}}$$

$$Sim_{ij} = \frac{|S_{i,j}(\tau)|}{|S_{i,j}(\tau)| + \varepsilon} \cdot |p_{ij}|$$

**Adjusted cosine similarity:–** It is a modified form of vector-based similarity where the authors have taken items and their ratings as vectors, some users might rate items highly , and others might give items lower ratings as a choice. To cut this drawback from vector-based similarity, we subtract average ratings for each user from each user's rating for the pair of items. The formula for adjusted cosine similarity is as following:

$$sim(i,j) = \frac{\sum_{u \in U_{ij}} (R_{u,i} - \overline{R_u})(R_{u,j} - \overline{R_u})}{\sqrt{\sum_{u \in U_{ij}} (R_{u,i} - \overline{R_u})^2} \sqrt{\sum_{u \in U_{ij}} (R_{u,j} - \overline{R_u})^2}}$$

is the average of the $u^{th}$ user's ratings and $R_{u,i}$ the user has rated an item i and $R_{u,j}$ the user has rated an item j.

**Log likelihood similarity: -** This similarity relies on calculating similarity between two users or items based on statistics that resolve around occurrences related to these users or items. Log likelihood focuses on events where these users or items overlap in preferences, events where both users or items have preferences where the compared user or item does not, and events where both users or items don't have preferences.

**Euclidian distance similarity:** The simple and most common example of a distance measure is Euclidian distance. The formula is:

$$d(x,y) = \sqrt{\sum_{k=1}^{n} (x_k - y_k)^2}$$

Where n is the number of dimensions(attributes) and $X_{K \text{ and}}$ $Y_k$ [are] the $k^{th}$ attributes (components)of data objects x and y respectively.

 **Tanimoto coefficient similarity:** It is a ratio of the overlap part to the whole set. Its expression over two bit vectors can be written as

$$T(A,B) = \frac{A \cdot B}{|A|^2 + |B|^2 - A \cdot B} = \frac{\sum_{i=1}^{n} A_i \times B_i}{\sum_{i=1}^{n} (A_i)^2 + \sum_{i=1}^{n} (B_i)^2 - \sum_{i=1}^{n} A_i \times B_i}$$

## II. Literature Review

 **Combined predictor for item based collaborative filtering[1].**This paper proposed a slope one and item-based nearest neighbor collaborative filtering algorithms, which is analyzed on Movie Lens dataset. Recommender system has important technology is known as collaborative filtering. To make a user-item relationship strong the process of making predictions about user preferences for product or services. Slope one and item-based nearest neighbor model have many advantages and it is taken by new combine approach to strive for better accuracy and rationality. Item-similarity is pre-computed offline. Further improvement of the performance, bias effects and simple gradient descent is used. When using slope one item-based nearest model alone, the experimental results show that the proposed final solution achieves great improvement of prediction accuracy. Finally, experiments are performed on dataset. Slope-one and item-based nearest neighbor CF algorithm has bad accuracy. Slope one CF is easy to implement, efficient, updatable and able to solve cold start problem. It has not good accuracy. The item based nearest neighbor model identifies some of the most similar items within past ratings, to predict ratings for a new user-item pairs. It has an ability to generate predictions with less online computing.

 **GPU accelerated item based collaborative filtering for big data applications [2].** In this paper authors proposed two parallel, item-based recommendation algorithms using the CUDA platform. For online service provider's recommendation system is popular marketing strategy. Customer's future preference is predicted by recommendation system from the past behaviors of the customer and other customers. Most of the online stores process millions of the transaction per day. It can be a challenging by providing quick and quality recommendations using large collections of data using past transactions. To accelerate the recommendation process, parallel processing power of GPUs can be used. GPU card has a limited amount of memory available on it. Thus, a number of passes required to completely process a large scale dataset. The user item data which has a high sparsity, two compression techniques are utilized by authors to reduce the required number of passes and increase the speed up. The experimental result relies on synthetic and real world datasets show that algorithms proposed by author outperform the respective CPU implementation also naïve GPU implementation which does not use compression.

 **An optimized item based collaborative filtering recommendation algorithm [3].** This paper describes the algorithm for optimizing item based collaborative filtering algorithm using recommendation system. Precious technology in E-Commerce is collaborative filtering. Users and commodities are increased unfortunately; the user rating data is not dense very much. Therefore, resultant collaborative filtering recommendation is less efficient. To address this issue, authors presented an optimized CF algorithm which is based on item. To obtain a proportion of users, who rated both items to those who rated each of them, at that time to calculate the similarity of two products. Authors have taken a ratio into account in this method. To make the better quality of CF, the authors proposed an algorithm. Item based collaborative filtering algorithm is based on such an assumption if majority of users rates some items similarly, and then the active user will rate the items similarly. The goal of the collaborative filtering is to suggest a new item.

 **Enhanced prediction algorithm for item- based collaborative filtering recommendation [4].** This paper proposed a new innovative approach to provide the enhance prediction quality that helps the protection against the influence of malicious ratings or unreliable users. As a use of internet is increasing day to day, a vast number of applications present to retrieve full potential which is offered by the infrastructure. It is most representative systems for personalized recommendations in E-com which is shown on web. It is a system that helps the users to search the information or retrieves the data easily. But traditional collaborative filtering has major drawback and it is suffering from drawbacks with evaluation of quality: Data sparsity, scalability and users are not

reliable. Additionally, an item based approach is used to reduce the sparsity of data and scalability problems. The authors combined item confidence and item similarity. The combination of both is known as item-trust and its value are used for online predictions. The proposed method gives valuable benefits in terms of improving the prediction quality.

**Item based collaborative filtering recommendation algorithms [5].** Authors analyzed various recommendation generation algorithm which is based on item. During live interaction, recommendation system applies knowledge discovery techniques to the problem of making personalized recommendations for information, products or services. These systems are based on k-nearest neighbor collaborative filtering and they get success on web. Due to fast and strong quantity in the amount of available information and number of visitors who visit to web sites in recent years poses some key challenges for recommendation systems. These are creating high quality recommendations, and perform many recommendations per second millions of users. The number of participants in the system, the amount of work increases in traditional collaborative filtering systems. To produce high quality recommendation, performs many recommendations per second for millions of user and item and get high coverage in face of data sparsity. New recommendation systems are needed for produce the high quality recommendations. To recover these issues authors have proposed item-based collaborative filtering techniques. For recognize the relationship between different items, Item-based techniques first perform the analysis operation of the user-item matrix. These relationships are used to indirectly compute recommendation for users. The authors look into different techniques for computing item-item similarities. The example of item-item similarities is item-item correlation vs. cosine similarities between item-vectors. Different techniques for obtaining recommendations from them. Weighted sum vs. regression model is example of this technique. The authors evaluate the result and compare them to the basic k-nearest neighbor approach. For achieve the better performance, the experiments suggest the item-based algorithms than user-based algorithms. Item-based algorithms also provide the better quality.

**Item-based collaborative filtering recommendation algorithm combing item category with interestingness measure [6].** In this paper, the authors proposed a novel CF recommendation algorithm by consuming item categories similarities and interestingness measure is invented. They proposed the algorithm for overcome the limitations of data sparsity and similarities which are not accurate in personalized recommendation systems. The items categories similarity matrix is build, by evaluating the item-item category distance and then analyzing of various items by using interestingness measure. By merging the information of item categories with item-item interestingness and utilize improved conditional probability method as the standardize item-item similarity measure, an improved collaborative filtering algorithm is produced by authors. To reduce the data sparsity problem and obtain better prediction accuracy than the others collaborative filtering algorithms, it is shown by experimental results.

**Typicality based collaborative filtering algorithm [7].** Authors proposed newly CF recommendation method named Tyco. Recommendation system has an important technology which is collaborative filtering. There are many problems such as recommendation isn't accurate, big error in prediction and data are not dense. This algorithm has a characteristic of finding "neighbors" of users based on user degrees which are typical in user groups which include a common user of items as in traditional collaborative filtering. In term of Mean absolute error (MAE), On recommendation accuracy, Tyco performs many CF recommendation methods. The improvement result is at least 6.35% in Movie Lens dataset, has a sparse training data and has very low time cost than others CF methods. By using less number of big error predictions, it also gets more accurate predictions.

**New hybrid recommendation system based on C-means clustering method [8].** In this paper, authors proposed a hybrid recommendation system with c-means clustering method to attain a better and faster recommendation system. In E-commerce, recommendation system is widely used. They have a better ability to know user's interest and suggest a best product to the consumers automatically. The users and products can be combined in same groups based on their similar features. These groups can help to improve recommendations and help these systems to solve problems. Many clustering methods used in recommendation systems but some methods are easy to use. So they can make a recommendation process and user feedback faster. Good recommendation is very useful than having too many recommendations and they can take a user attention.

**Simulation resource recommendation system based on collaborative filtering [9].** In this paper the authors have proposed a method for recommended interested simulation resource or item which is based on the neighbor users' preferences. Recommendation system is based on user preferences to recommend the resources that may user interest. The user interested items are ranked or graded by the recommendation system and collected in records. All types of simulation resources that are presents in simulation resource management. But in recently,

recommendation system suffers from the problems of data sparsity, cold start, accuracy and efficiency. So simulation resource based on collaborative filtering provides a solution to improve the efficiency in searching and performance of simulation resources system. The collaborative filtering system is model based, to analyze and combine the recommendation system with simulation resource systems, the simulation resource recommendation system is analyzed and designed. Three main procedures are including in realization: collecting user preferences, finding neighbor users and recommended simulation resources. Recommendation system uses the Pearson correlation to calculate the similarity between the users then find out the neighbor users. Then the recommendation system is depending on neighbor users which can help to predict the user's grade or rank of resource and then get the recommended resources. Simulation resource system rely on searching function to get simulation resource, which is based on searching engine, user input the keywords and search engine match information. The result show that recommended resources have strong similarity with the user's previous preference. Recommended resources use the frequency and improve the efficiency of resources obtained. Recommendation system uses simulation resource database. This database is very useful for storage of all data, models and files. Many kind of users like simulation experimenter and simulation analyst are access this database.

**Item- to item collaborative filtering method [10].**

Authors have proposed algorithm to personalize online store for each customer. It means user can purchase the any products online according to their preferences. This algorithm is developed by Amazon. Amazon is a commercial website of collection of items. Intention of this algorithm is that instead of search the neighborhood users who share the similar interest on items with the active user, it finds the items been purchased together with the current item. The similarity between the items can also calculated. It provides the facility to rebuild the index in offline part and it is also incrementally maintainable. The online part of collaborative filtering on item trust is either a phase of recommendation or prediction [4]. It requires no more time than the others collaborative filtering method. This approach is suffered from cold start problem and it has a low quality of product. It is widely used in E-commerce website.

## III. Future Work

Recommendation engine is widely used in various internet activities and their value is increasing due to information overload problem, which is arising from internet. Recommender systems are becoming integral to how consumers discover media. It provides various types of suggestions that remove large information spaces effectively. we developed a recommendation system using an item based approach to build a net that filters items according to their degree of desirability and recommend items according to requirements of users. The proposed recommendation system has good performance with regard to objective indicators and consistent performance regardless of data size, and could improve the applicability of the model. To improve the quality of the recommendation system, an optimized item-based collaborative filtering algorithm is often useful. The quality of the recommendation is based on accuracy of prediction rating score [3].

For future work this scheme further improved to rank the item based on user's preference. We will implement this algorithm using item based algorithm or hybrid approach.

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