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Study of machine learning based recommendation techniques used by E-commerce

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Abstract
"Customer who viewed this item wills also view that" is an intelligent as well as expert activity that keeps track of customers. Online shopping trends are based on the statistics which execute cross-selling mechanism. This intelligent algorithm will suggest your site visitors with products which were mostly explored by other customers on basis of maximum ratings, purchased or liked and viewed. These suggestions display on product pages that are based on the current product. Various Shopping application and web-sites are using different methods to attract customers. In this paper we are going to study the algorithm and introduction to machine learning approach to find how E-commerce uses recommendation techniques.

Keywords: Artificial Intelligence, Recommendation System, Collaborative filtering, Content based Recommendation.

1. Introduction

Recommendation systems are a subclass of information filtering system that seek to predict the "rating" or "preference" that a user would give to an item.[1][2] Recommendation systems have become increasingly popular in recent years, and are utilized in a variety of areas including movies, music, news, books, research articles, search queries, social tags, and products in general. There are also recommender systems for jokes, restaurants, garments, financial services, life insurance, marriage portal sites, social media sites such as facebook and Twitter pages[7].

Amazon, is an American electronic commerce and cloud computing company, It is the largest Internet-based retailer in the world by total sales and market capitalization [3]. Online shopping is a form of electronic commerce which allows consumers to directly buy goods or services from a seller over the Internet using a web browser. As of 2016, customers can shop online using a range of different computers and devices, including desktops, laptops, tablet computers and smartphones.

Amazon uses Item Based Collaborative filtering. Purchase logs are converted into a simple TSV file containing the customer id, item id (ASIN), date and whether it was a purchase/view/watch. A C++ program then computes the actual similarities using the collaborative filtering algorithm (it also takes into count when co-occurring items are purchased).

2. Content Based Recommendation (CBR): CBR provides personalized recommendation by matching user's interests with description and attributes of items. For CBR, we can use standard ML techniques like Logistic Regression, SVM, Decision tree etc. based on user and item features for making predictions for eg: extent of like or dislike[5]. Then, we can easily convert the result to ranked recommendation.

Collaborative filtering(CF): Neighborhood models are heuristics based models which uses similarity metrics, for eg : pearson similarity, cosine similarity, for finding similar users and items [4]. It is based on, very reasonable, heuristic that a person will like the items that are similar to previously liked items. Rating prediction in item based neighborhood models is given by weighted average of ratings on similar items as shown below:

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$$\hat{r}_{u,i} = b_{u,i} + \frac{\sum_{j \in N(i,k,u)} s_{i,j}\left(r_{u,j} - b_{u,j}\right)}{\sum_{j \in N(i,k,u)} s_{i,j}}$$

Formula: Recommendation based on like

where, N(i, k, u) is a set of k items that are similar to i and rated by the user u; si,jsi,j is a similarity function (cosine or pearson correlation).

As there is no learning involved in above equation, any ML expert will say that this sucks (although it works pretty well in practice). So, in a quest of 1 million bucks (Netflix challenge), some smart people (Yehuda Koren et al.) thought about it and reformulated it as

$$\hat{r}_{u,i} = b_{u,i} + \sum_{j \in N(i,k,u)} \theta^{u}_{i,j}\left(r_{u,j} - b_{u,j}\right)$$

Formula: Neighbor item based Recommendation

it looks like linear regression with θui,jθi,ju as parameters". So, Instead of using ad-hoc heuristic based si,jsi,j to weight the ratings, now the weights, θui,jθi,ju, are learned. Note that, it was crucial in winning Netflix prize. This is just an instance, out of many, of ML in recommendation. Matrix Factorization learns user and item latent factors (U an V) by minimizing reconstruction error on observed ratings. Formally, in an optimization framework it is given as

$$\min_{U,V} \sum_{u,i} \left(r_{ui} - U_u^T V_i\right)^2 + \lambda\left(\|U\|_2^2 + \|V\|_2^2\right)$$

Formula: Based on Rating

First of all, when there is an optimization technique involved, it's definitely a ML thing.

Let's make this clearer by converting it to our own favorite Linear regression problem. So if you fix any one of the latent factor, say U, then it becomes linear regression on V. This way of optimization is well known in literature as ALS(alternating Least Squares).

Bayesian ML people, who not only want point estimates but also uncertainty of the estimates, will reformulate the same problem into probabilistic setting and learn in their own bayesian way.

3. Machine learning and Cold Start

Cold start is a situation when a recommender system doesn't have any historical information about user or item and is unable to make personalized recommendations. Cold start is the worst nightmare of any recommender system researcher [6].

So one way to deal with cold start is eliciting new user's preferences via initial interview. However, interview based elicitation is not useful as user often get bored when they are asked a series of questions. Now, ML guy can use his decision tree knowledge to learn a model that smartly chooses a minimum set of the question while learning user's preference.

Furthermore, there is a vast literature on Learning to rank for recommendation. Although, Learning to rank shares DNA with Information retrieval, its more ML technique.

3. Recommendation based on DataBase

A recommendation service is a computer-implemented service that recommends items from a database of items. The recommendations are customized to particular users based on information known about the users[8]. One common application for recommendation services involves recommending products to online customers.

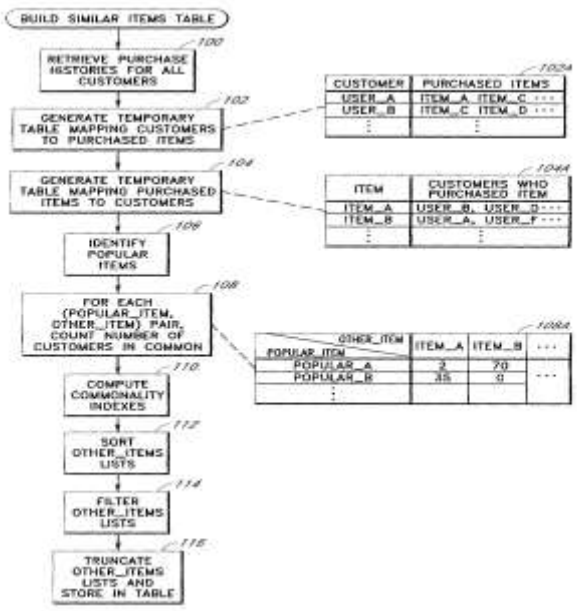

Fig: Recommendation Techniques.

Figure above shows Illustrates a Web site which implements a recommendation service which operates in accordance with the invention, and illustrates the flow of information between components.

4. Conclusions

Recommender systems (RS) are widely used in e-commerce, social networks, and several other domains. One progressive step in RS history is the adoption of machine learning (ML) algorithms, which allow computers to learn based on user information and to personalize recommendations further. Machine learning is an Artificial Intelligence (AI) research field that encompasses algorithms whose goal is to predict the outcome of data processing. ML has made major breakthroughs in the fields of image recognition, search engines, and security.

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