A Novel Cross-Site Product Recommendation Method in Cold Start Circumstances

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Abstract: In the last 20 years, more than 250 research articles were published about research paper recommender systems. In the recent years, the farthest point between internet business applications such as e-commerce websites and social networking applications has interpersonal communication and it has turned out to be progressively obscured. Numerous e-commerce web and mobile applications allowing social logging mechanism where their clients can signing in their websites using their personal social network identities such as twitter or Facebook accounts etc. users can likewise post their recently purchased items on social networking websites with the appropriate links to the e-commerce product web pages. In this paper, we propose a new solution to recommend products from e-commerce websites to users at social networking sites. a noteworthy issue is how to leverage knowledge from social networking websites when there is no purchase history for a customer, especially in cold start situations.in particular, we proposed the solution for cold start recommendation by linking the users to social networking sites and e-commerce websites i.e. customers who have social network identities and have purchased on e-commerce websites as a bridge to map user's social networking features into another feature representation which can be easier for a product recommendation. Here we propose to learn by using recurrent neural networks both user's and product's feature representations called user embedding and product embedding from the data collected from e-commerce website and then apply a modified gradient boosting trees method to transform user's social networking features into user embedding. Once found, then develop a feature-based matrix factorization approach which can leverage the learned user embedding for the cold-start product recommendation. Experimental results show that our approach effectively works and gives the best-recommended results in cold start situations.

Keywords *– social networks, e-commerce, product recommendation, recurrent neural networks.*

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I. INTRODUCTION

Recommender Systems (RS) are programming tools and methods giving recommendations for items to be useful to a user [1]. The recommendations identify and helpful in decision-making processes, such as what products to buy, what music to listen to, or what online news to read. Currently, there are different application domains utilizing the methods of recommender systems. Based on these specific application domains, we define more general classes of domains for the recommender systems. In Entertainment we can recommend the movies, music to the users, to recommend e-papers, magazines, recommendations for documents, recommending web page or websites. In E-commerce, we can recommend the products such as books, mobiles or other computer accessories. We can provide several services such as recommending travel services, expert doctor consultations, recommendation houses to rent or purchase, recommending the job portals etc. [2, 3]. To recommending these types of services RS systems can use mainly their kinds of methods such as content-based filtering, collaborative filtering, and hybrid based filtering

Now a days the microblogging websites are getting huge popularity based on the spending time to post the tweets, sharing images, videos etc. It is good idea to recommend the products in the social websites to recommending the products instead of recommending the products in e-commerce website, where the user's spending less time to purchase the products. We have listed the top-5 micro blogging websites based on Alexa and PR in Table 1.

S.no	Micro Blogging sites	PR	Alexa	PA
1	Twitter.com	10	10	96.95
2	Tumblr.com	8	31	93.85
3	Posterous.com	8	1528	88.3
4	Friendfeed.com	8	1644	90.24

Table 1: List of Top 5 Microblogging websites

In recent years, inter personal communication between e-commerce and social networking have gotten progressively obscured. E-commerce websites such as eBay, flip kart highlights some features of social networks, including ongoing notices and other communications between its customers and dealers. Some e-commerce websites additionally bolster the mechanism of social login, which allows new user to sign in with their existing login information from social networking services such as Google+, Facebook, and Twitter. Recently Face book and

Twitter presented another new feature that allowing their users to purchase products directly from their websites by just clicking "purchase now or buy now" button to purchase products in adverts or different posts. Not only e-commerce web sites the e-paper websites such as TOI is now allowing some adverts in their websites and we can purchase the products by clicking on the link. In china, e-commerce company ALIBABA has made a strategic investment in SINA WEIBO product adverts can be directly delivered in SINA WEIBO users. With these kind of new trends of conducting e-commerce activities on social networking sites, it is important to pull knowledge extracted from social networking web sites for the development of product recommender systems.

Recommending products in e-commerce web sites is a common challenge in analytics. An interesting issue here is that recommending products for the customers who don't have any historical records for him. This situation is called cold-start situation. In this paper, we concentrate an intriguing issue of recommending products from e-commerce websites to users at social networking websites who don't have any historical purchased records called cross-site cold-start product recommendation [4, 5, 6].Though we have extensively studied some product recommendation techniques, those studies are related to recommending the products and mostly constructing solution inside the e-commerce system mainly utilizing their user's historical transactions. To best of our insight, cross-site cold start product recommendation has examined some times recently. In this kind of problem setting here, only the users social networking information is available and it is challenging task to covert the social networking information in to latent user features which can be effectively used for product recommendation.

To address this challenge, we proposed to utilize the connected users in both social networking sites and e-commerce websites (those who have social networking accounts and have purchased on e-commerce websites) as a bridge to map user's social networking features to latent features for recommending the products. With the help of recurrent neural networks we can learn both users and products feature representations and then apply a gradient boosting tree technique to convert user's social networking features in to user embedding's. At last we develop a feature based matrix factorization approach which can leverage the learnt user embedding for cold start recommendation. Experimental results of our work shows that it works effectively works for cross site cold start recommendation.
The structure of the paper is as follows:
Section II describes formulation of proposed problem and basic frame work of our work. In Section III, we described to extracting and representing micro blogging attributes and how to applying the transformed features to cold-start product recommendation; Section IV discussed the novel application of cold start recommendation. Section V lists our experimental results and analysis. Conclusions are drawn in Section VI.

II. FORMULTING THE PROBLEM

Given a web based e-commerce website. Let U denotes a set of users, P denotes a set of products and R denotes a purchase record matrix such that |U| x| P|. Each entry in the record matrix $r_{u,p}$ indicates a binary value indicating whether the user u has purchased the product p or not. Each user $u \in U$ is associated with a set of purchased products with the purchase timestamps. Furthermore, a small subset of users in U can be linked to their micro blogging accounts (or any other social networking accounts), denoted as $U^{L.}$. it means that each user $u \in U^L$ is also associated with their respective microblog information. Let 'A' denote the set of microblogging features, each micro blogging user has a |A|-dimensional micro blogging feature vector a_u in which each $a_{u,i}$ is the attribute value for the i-th micro blogging attribute feature. From the notations introduced above, we can define our recommendation problem as follows. We proposed the idea of cross-site cold start recommendation problem as: a micro blogging user $\notin U$' whois new to the e-commerce website and has no historical purchase records. $u' \notin U^L$ since $U^L \subset U$. we proposed to generate a personalized ranking of recommended products for u' based on micro blogging attributes $a_{u'.}$ The entire work follow of our solution is shown in Figure 1. It consists of four major steps. First we extract the microblogging attributes from the social media, second train the purchase record with paragraph2vect method, and third apply the heterogeneous mapping using MART. Finally apply the feature based matrix factorization with both a_u and v_u

The complete work has done in this paper is summarized here. The main problem we have taken here is that recommending the products from e-commerce website to social network users in cold-start circumstances. First we applied recurrent neural networks for learning both user and product feature representations from data collected through e-commerce website. Secondly, applying the modified gradient boosting tree technique to transform the user's social networking attributes i.e. micro blogging attributes to latent feature representation, which can be helpful for product recommendation. Third, we applied feature based matrix factorization approach by incorporating user and product features for cold-start product recommendation. It is challenging task to find the recommendations to the users who don't have any purchase history in the e-commerce website. In this sense micro blogging attributes can be used for this kind of recommendations. Next we, will study how to extract microblogging features and transform them into a distributed feature representation before presenting a feature based matrix factorization approach, which incorporates the learned distributed feature representations for product recommendations.

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Microblogging website E-commerce site

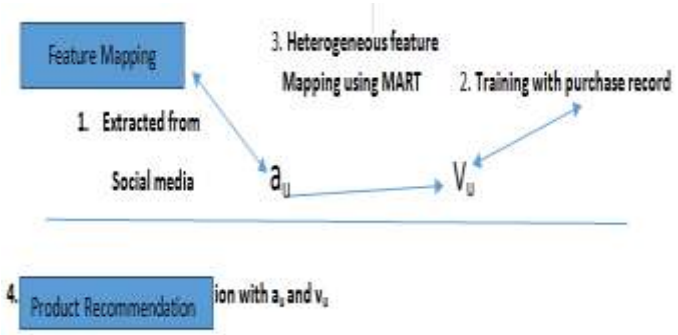

Figure 1: Work flow diagram

III. PROPOSED WORK

In order to recommend the products in the cold start situations, first we have to extract the attributes from the microblogging websites and transform them in to feature map representation to recommend the products. The process is explained step by step.

A. Extracting and Representing Microblogging attributes

We can learn microblogging attributes in three stages

1. Collect a list of useful microblogging attributes and construct a microblogging feature vector a_u for each linked user $\mathbf{u} \in \mathbf{U}^{L}$.
2. With the help of deep learning generate a distributed feature representation $\{V_u\}$ in u belongs to U using the information from all users U on the e-commerce site.
3. Learn the mapping function $f(a_u) \rightarrow v_u$ which converts the microblogging attribute information in to a distributed feature representation which is in the second step. It uses the pair of feature representations $\{au,vu_{}\}$ of all the linked users in $U_{L.}$ This is considered to be as training data.

B. Microblogging Feature Selection

For a particular microblogging user $a_{u,}$ now we will see how to extract information from the microblogging website. According to our knowledge the microblogging attributes are divided in to four categories. They are demographic attributes, text attributes, and network attributes, temporal attributes [7, 8]. We have listed the attributes comes under each category in Table 2. A demographic profile of the user such as gender, marital status, career interests etc. can be used by the e-commerce companies to provide better personalized services. To extract the text attributes topic distributions, word embedding techniques can be useful. It is clear that users connected together with some links, hence extracting network attributes also used for product recommendations. The temporal attributes such daily activity and weekly activity distributions of a user can give the interests of the user, which can be helpful in the product recommendation.

Type of Attribute	Features
Demographic Attributes	Gender Age Marital Status Education Career Interests
Text Attributes	Topic Distributions Word Embedding
Network Attributes	Latent Group preferences
Temporal Attributes	Daily activity distribution Weekly activity distribution

Table 2: Categorization of Microblogging attributes.

C. Distributed Representation Learning

We cannot directly establish a connection between a_u and products with the earlier steps. Intuitively, users and products should be represented in the same feature space so that user is closer to the products that she has purchased compared to those she has not purchased. With the help of recently proposed approach recurrent neural networks we can learn user embedding's or the distributed representation of user $V_{u.}$ Before learning to user embedding it is good to learn the product embedding. There are two recurrent neural architectures [9] to train the product embedding's. They are CBOW (Continuous Bag-Of-Words) model and Skip-gram model. The main difference between these two models is that CBOW predicts the current product with the surrounding context whereas Skip-gram will find the surrounding context based on the current product. The conditional prediction probability is characterized by the softmax function shown below:

$$P_r\,(p_t \mid \text{context}) = \frac{\exp(V^{T}pt \,.\, V_{context})}{\sum_p \exp(V^{T}pt \,.\, V_{context})}$$

After learning the product embedding's similarly we can learn the user embedding's with the help of Paragraph Vector (para2vec) method [9], which learns the feature representation from variable-length pieces of text, including sentences, paragraphs and documents. We implemented the simplified version of para2vec at sentence level. Here we considered the purchase history of the user and can be considered as a "sentence", it consists of product IDs and word tokens. A user ID is placed at the beginning of the sentence and both user IDs and product IDs are treated as word tokens in a vocabulary in the learning process. When Training the dataset, for each sentence, the sliding context window will always include the first word i.e. user ID in the sentence. Due to this reason, a user ID is always associated with a set of purchase records. We can use the same learning procedure in word2vector for computing the P_r(context| p_t)and P_r (p_t |context). We represented the two architectures in Figure 2. Later, we separate the user embedding's from product embedding's and use v_u and v_p to denote the learnt

K-dimensional embedding for user u and product p respectively.

D. Applying the Transformed Features to Cold-Start Product Recommendation

MART is one of the most widely used gradient tree boosting method for predictive data mining such as in regression and classification. We applied this algorithm for finding the features. Once the MART learners are built for feature mapping, the original microblogging feature vectors au are mapped onto the user embedding v_u.

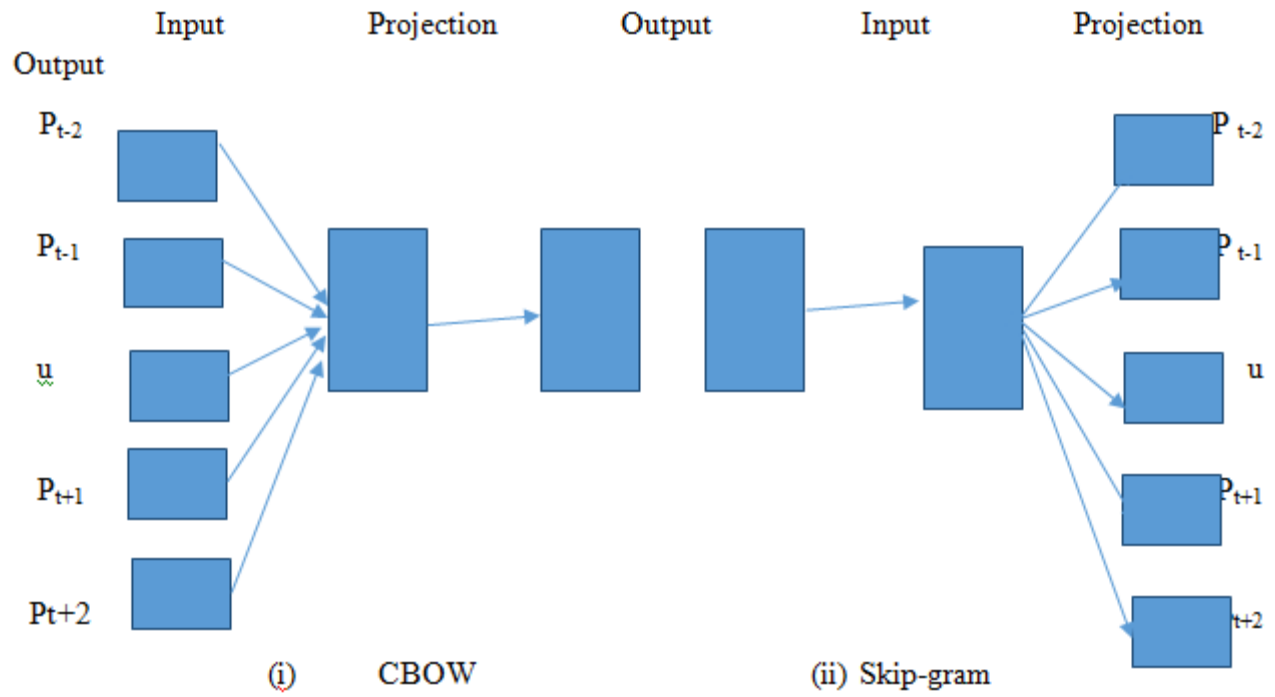

Figure 2: Two architectures to learn both product and user embedding's; here u is the user ID.

In this section, we study how to incorporate {au, vu} into the feature based matrix factorization technique.In specific, we develop our recommendation method based on the recently proposed SVDFeature [10]. Our idea can also be applied to other feature-based recommendation algorithms, such as Factorization Machines [11]. SVDFeature is built with the help of traditional matrix factorization approach. It considers the matrix factorization approach in three aspects. They are dynamic features (global features), user features and item features.

It can be recommended for the task of product recommendation as follows:

$$r_{u,p}(\alpha^{(u)}, \beta^{(p)}, \lambda^{(u,p)})$$

Where $\alpha^{(u)}$belongs to $R^{N}\alpha$, $\beta^{(p)}$belongs to $R^{N}\beta$, $\lambda^{(u,p)}$belongs to $R^{N}\lambda$ are the input vectors consisting of the features of user u, the features of product p and the global features for the pair (u,p) with the lengths of N_α , N_β, N_λ. User- Product pair corresponds to a feature vector concatenated by global features, suer features. The response value to be fitted indicates whether the user has purchased the product or not.

IV. APPLICATIONS

The main advantage of this approach is to recommend the users who are new to the e-commerce website. We can recommend the products to those users and increase the business of e-commerce organizations. In other words, with the derived model, we can recommend the products from e-commerce websites to users in online social networks such as Facebook, Twitter etc. For this kind of recommendation the only information that existing for us are microblogging attributes. Using MART we can derive the fitted user embedding's. In other terms we should not require any purchase history of the users to recommend products. Thus the proposed approach can recommend the products in cold-start situations.

V. RESULTS

The complete work is divided in three stages. In the first stage, the user can create the account in any of the social network. User can do all the activities such as he can tweet the messages, share the text, audio, video etc. the admin will collect the microblogging attributes of the user and he can map the attributes based on their interests. On the other hand, we collected some items from the e-commerce websites. The admin here is responsible to maintain the details and he has all the permissions on the e-commerce website. Based the features collected from the microblogging website the admin can recommend the products to the users who are working in social network websites. Third, we are maintaining a link between the e-commerce website and social networking website. As of our knowledge there are many algorithms for recommending the product, but very less work has done on cross-site

recommendation in cold start situations. Our work will recommend the products who don't have the previous purchase history in e-commerce website by considering the microblogging attributes. This method works effectively and giving the best recommendation compared to the existing methods. We have shown the sample screens of output how to add the details of a product how the admin can view the microblogging attributes in Figure 3 and Figure 4.

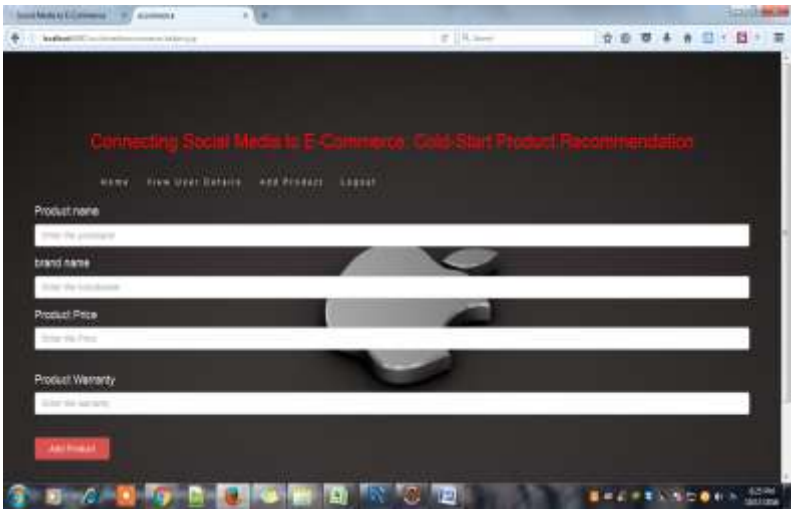

Figure 3: Adding product details

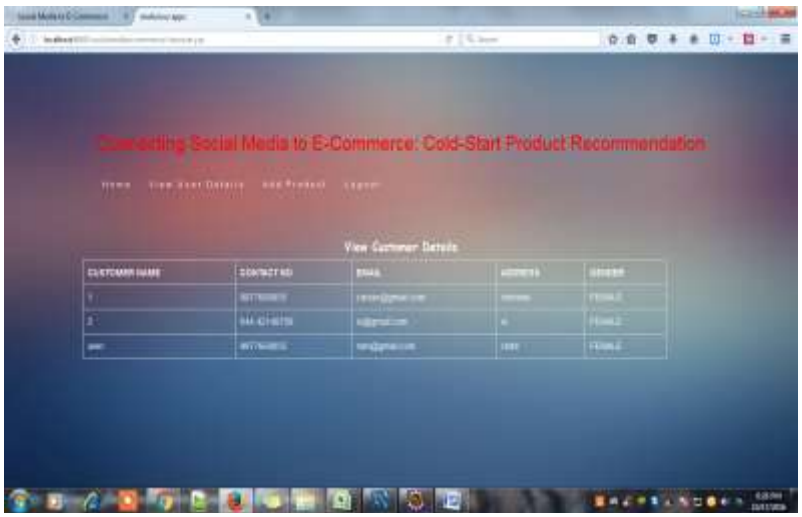

Figure 4: View of the user along with microblogging attributes.

VI. CONCLUSION

In this paper, we have concentrated a novel issue, cross-site cold-start recommendation problem; recommending the product items from online e-commerce websites to social network users without having any previous history of records of that users. Our primary thought is the e-commerce websites, users and items are represented in the same latent feature space through the feature learning with the recurrent neural networks. By utilizing the linked users across the e-commerce websites and social networking websites as a bridge, we can learn the feature mapping functions suing the recent method called gradient boosting trees. This method will map the user's attributes i.e. collected from social networking site to feature representation learned from e-commerce sites.

The mapped user features can be successfully consolidated in to a feature-based matrix factorization approach for cold-start product recommendation. We trust that our review will have significant effect on both research and industry groups.at present we have implemented just a straightforward neural network architecture for user and product embedding's. Later on, more propelled deep learning methods such as convolutional neural networks can be investigated for feature learning. We will likewise consider enhancing the present feature mapping method through thoughts in transferring learning. [12].

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