Social Recommendation with Learning Personal and Social Latent Factors

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***Abstract*—** *Due to leveraging social relationships between users as well as their past social behaviour, social recommendation becomes a core component in recommendation systems. Most existing social recommendation methods only consider direct social relationships among users (e.g., explicit and observed social relations). Recently, researchers proved that indirect social relationships can be effective to improve the recommendation quality when users only have few social connections, because it can identify the user interesting group even though the users have no observed social connection. In the literature, separate two-stage methods are studied, but they cannot explicitly capture the natural relationship between indirect social relations and latent user/item factors. In this paper, the main contribution is to propose a new joint recommendation model taking advantage of the Indirect Social Relations detection and Matrix Factorization collaborative filtering on social network and rating behaviour information, which is called as InSRMF. In our work, the user latent factors can simultaneously and seamlessly capture user's personal preferences and social group characteristics. To optimize the InSRMF model, we develop a parallel graph vertex programming algorithm for efficiently handling large scale social recommendation data. Experiments based on four real-world datasets are conducted to demonstrate the performance of the proposed model. The experimental results have shown that InSRMF has ability to mine the proper indirect social relations and improve the recommendation performance compared with the testing methods in the literature, especially on the users with few social neighbours, Near-cold-start Users, Pure-cold-start Users and Long-tail Items.*

I. INTRODUCTION

An indispensable information filtering technique, recommendation system is nowadays ubiquitous in various domains, such as the recommendation of products at Amazon, books/movies/music at Douban, research articles on Cite Like, etc. It aims to provide personalized recommendation and improve the user experience. In the last decade, the collaborative filtering methods based on matrix factorization (MF) gain popularity and become the standard model for recommendation. MF factorizes the user-item preference matrix to find the latent user and item factors and completes the original incomplete preference matrix by multiplying these two latent factors. Even though a lot of MF-based recommendation methods have been proposed and lead to promising results, they suffer from data sparsity and perform poorly on cold-start users who have no or few past behaviour data.

1.1 Knowledge Engineering

Knowledge engineering is a field of artificial intelligence (AI) that creates rules to apply to data to imitate the thought process of a human expert. It looks at the structure of a task or a decision to identify how a conclusion is reached. A library of problem-solving methods and the collateral knowledge used for each can then be created and served up as problems to be diagnosed by the system. The resulting software could then assist in diagnosis, trouble-shooting, and solving issues either on its own or in a support role to a human agent.

- Knowledge engineering is a branch of artificial intelligence (AI) that develops rules that are applied to data in order to imitate the thought process of a human that is an expert on a specific topic.
- In its initial form, knowledge engineering focused on the transfer process; transferring the expertise of a problem-solving human into a program that could take the same data and make the same conclusions.
- It was determined that transfer processing had its limitations, as it did not accurately reflect how humans make decisions. It did not consider intuition and gut feeling, known as analogous reasoning and nonlinear thinking, that often may not be logical.

- Today, knowledge engineering uses a modelling process that creates a system that touches upon the same results as the expert without following the same path or using the same information sources.
- The goal of knowledge engineering is for it to be implemented into software that will make decisions that human experts would, such as financial advisors.
- Knowledge engineering is already being used in decision support software and it is expected that at some point it will be used to make better decisions than human experts.

1.2 Knowledge Engineering to Exceed Human Experts

Knowledge engineering sought to transfer the expertise of problem-solving human experts into a program that could take in the same data and come to the same conclusion. This approach is referred to as the transfer process, and it dominated early knowledge engineering attempts.

It fell out of favour, however, as scientists and programmers realized that the knowledge being used by humans in decision-making is not always explicit. While many decisions can be traced back to previous experience on what worked, humans draw on parallel pools of knowledge that don't always appear logically connected to the task at hand.

Some of what CEOs and star investors refer to as gut feeling or intuitive leaps is better described as analogous reasoning and nonlinear thinking. These modes of thought don't lend themselves to direct, step-by-step decision trees and may require pulling in sources of data that appear to cost more to bring in and process than it is worth.

The transfer process has been left behind in favour of a modelling process. Instead of attempting to follow the step-by-step process of a decision, knowledge engineering is focused on creating a system that will hit upon the same results as the expert without following the same path or tapping the same information sources.

This eliminates some of the issues of tracking down the knowledge being used for nonlinear thinking, as the people doing it are often not aware of the information they are pulling on. As long as the conclusions are comparable, the model works. Once a model is consistently coming close to the human expert, it can then be refined. Bad conclusions can be traced back and debugged, and processes that are creating equivalent or improved conclusions can be encouraged.

Knowledge engineering is already integrated into decision support software. Specialized knowledge engineers are employed in diverse fields that are advancing human-like functions, including the ability of machines to recognize a face or parse what a person says for meaning.

As the complexity of the model grows, the knowledge engineers may not fully understand how conclusions are being reached. Eventually, the field of knowledge engineering will go from creating systems that solve problems as well as a human to one that does it quantitatively better than humans.

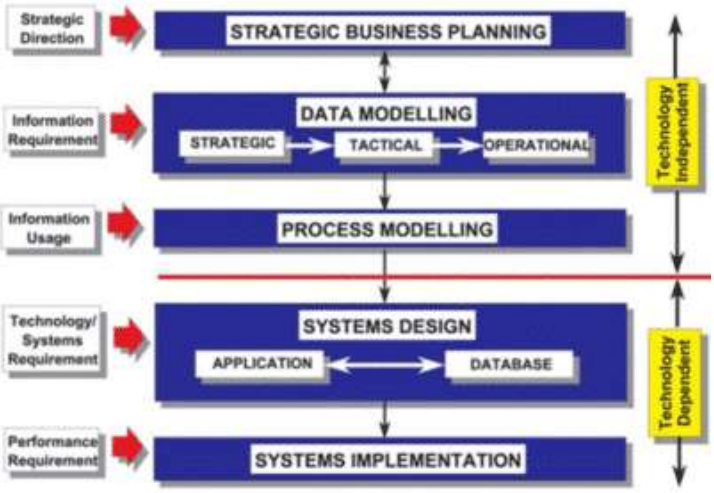
Coupling these knowledge engineering models with other abilities like natural language processing (NLP) and facial recognition, artificial intelligence could be the best server, financial adviser, or travel agent that the world has ever seen.

1.3 Data Engineering

The key to understanding what data engineering lies in the "engineering" part. Engineers design and build things. "Data" engineers design and build pipelines that transform and transport data into a format wherein, by the time it reaches the Data Scientists or other end users, it is in a highly usable state. These pipelines must take data from many disparate sources and collect them into a single warehouse that represents the data uniformly as a single source of truth.

Many would say that data engineering as a profession has been around for well over a decade, maybe a couple, ever since databases, Microsoft SQL Servers and ETL came to be. Some would say ever since IBM popularized database management systems in the 1970s. With that, here's a very brief history recap.

In the 1980s the term "information engineering" was coined to largely describe database design and to include software engineering in data analysis. Somewhere after the rise of the internet in the 1990s and 2000s, 'big data" came to be. Yet DBAs, SQL Developers and IT professionals working in the field were not labeled "Data Engineers" at that time.



The term "data engineering" evolved to describe a role that moved away from using traditional ETL tools and developed its own tools to handle the increasing volumes of data. As big data grew, "data engineering" came to describe a kind of software engineering that focused deeply on data – data infrastructure, data warehousing, data mining, data modelling, data crunching, and metadata management.

II. LITERATURE SURVEY

1. Author: Dong Qin 2019

Title: Context-aware social recommendation in sharing community

Description: In the social group recommendation, existing techniques mainly focus on small user groups. However, online sharing communities have enabled group activities among thousands of users. Accordingly, recommendation over big groups has become critical. We propose a new framework to accomplish this goal by exploring the group interests and the connections between group users. Compared with the existing work, the novelties of our proposed techniques are as follows. First, our proposed framework can fully mine various group preferences based on the user and item interactions rather than treating the preference of the whole group as unique. Then, our proposed framework improves the recommendation efficiency dramatically. The traditional recommendation approaches, such as collaborative filtering, generate recommendations based on the whole media in the database, resulting in much time cost. To reduce the time cost, our framework collects a comparably compact potential candidate set of media-user pairs, on which the collaborative filtering is performed to generate an interest subgroup-based recommendation list. Third, a novel aggregation function is proposed to integrate the recommended media lists of all interest subgroups as the final group recommendation result. It addresses the dynamic combination challenges in big group recommendation by considering both the subgroup contribution and activeness.

2. Author: Xiao Hu, Chuibo Chen, Xiaolong Chen, Zi-Ke Zhang,2012

Title: Social Recommender Systems Based on Coupling Network Structure Analysis

Description: The past few years has witnessed the great success of recommender systems, which can significantly help users find relevant and interesting items for them in the information era. However, a vast class of researches in this area mainly focus on predicting missing links in bipartite user-item networks (represented as behavioural networks). Comparatively, the social impact, especially the network structure-based properties, is relatively lack of study. In this paper, we firstly obtain five corresponding network-based features, including user activity, average neighbours' degree, clustering coefficient, assortative coefficient and discrimination, from social and behavioural networks, respectively. A hybrid algorithm is proposed to integrate those features from two respective networks. Subsequently, we employ a machine learning process to use those features to provide recommendation results in a binary classifier method. Experimental results on a real dataset, Flixster, suggest that the proposed method can significantly enhance the algorithmic accuracy. In addition, as network-based properties consider not only the social activities, but also take into account user preferences in the behavioral networks, therefore, it performs much better than that from either social or behavioral networks. Furthermore, since the features based on the behavioral network contain more diverse and meaningfully structural information, they play a vital role in uncovering users' potential preference, which, might show light in deeply understanding the structure and function of the social and behavioural networks.

3. Author: Peng-Peng Zhao, Hai-Feng Zhu, Yanchi Liu 2018

Title: A Generative Model Approach for Geo-Social Group Recommendation

Description: With the development and prevalence of online social networks, there is an obvious tendency that people are willing to attend and share group activities with friends or acquaintances. This motivates the study on group recommendation, which aims to meet the needs of a group of users, instead of only individual users. However, how to aggregate different preferences of different group members is still a challenging problem: 1) the choice of a member in a group is influenced by various factors, e.g., personal preference, group topic, and social relationship; 2) users have different influences when in different groups. In this paper, we propose a generative geo-social group recommendation model (GSGR) to recommend points of interest (POIs) for groups. Specifically, GSGR well models the personal preference impacted by geographical information, group topics, and social influence for recommendation. Moreover, when making recommendations, GSGR aggregates the preferences of group members with different weights to estimate the preference score of a group to a POI. Experimental results on two datasets show that GSGR is effective in group recommendation and outperforms the state-of-the-art methods.

4. Author: Xiangmin Zhou, Dong Qin, Lei Chen & Yanchun Zhang 2019

Title: Real-time context-aware social media recommendation

Description: Social media recommendation has attracted great attention due to its wide applications in online advertisement and entertainment, etc. Since contexts highly affect social user preferences, great effort has been put into context-aware recommendation in recent years. However, existing techniques cannot capture the optimal context information that is most discriminative and compact from a large number of available features flexibly for effective and efficient context-aware social recommendation. To address this issue, we propose a generic framework for context-aware recommendation in shared communities, which exploits the characteristics of media content and contexts. Specifically, we first propose a novel approach based on the correlation between a feature and a group of other ones for selecting the optimal features used in recommendation, which fully removes the redundancy. Then, we propose a graph-based model called *content–context interaction graph*, by analysing the metadata content and social contexts, and the interaction between attributes. Finally, we design hash-based index over Apache Storm for organizing and searching the media database in real time. Extensive experiments have been conducted over large real media collections to prove the high effectiveness and efficiency of our proposed framework.

5. Author: Yanchun Zhang, Dong Qin, Longbing Cao, Guangyan Huang & Chen Wang 2017

Title: Enhancing online video recommendation using social user interactions

Description: The creation of media sharing communities has resulted in the astonishing increase of digital videos, and their wide applications in the domains like online news broadcasting, entertainment and advertisement. The improvement of these applications relies on effective solutions for social user access to videos. This fact has driven the research interest in the recommendation in shared communities. Though effort has been put into social video recommendation, the contextual information on social users has not been well exploited for effective recommendation. Motivated by this, in this paper, we propose a novel approach based on the video content and user information for the recommendation in shared communities. A new solution is developed by allowing batch video recommendation to multiple new users and optimizing the subcommunity extraction. We first propose an effective technique that reduces the subgraph partition cost based on graph decomposition and reconstruction for efficient subcommunity extraction. Then, we design a summarization-based algorithm which groups the clicked videos of multiple unregistered users and simultaneously provide recommendation to each of them. Finally, we present a nontrivial social updates maintenance approach for social data based on user connection summarization. We evaluate the performance of our solution over a large dataset considering different strategies for group video recommendation in sharing communities.

III. PROBLEM STATEMENT

Most existing social recommendation methods only consider direct social relationships among users (e.g., explicit and observed social relations). Recently, researchers proved that indirect social relationships can be effective to improve the recommendation quality when users only have few social connections, because it can identify the user interesting group even though the users have no observed social connection. In the literature, separate two-stage methods are studied, but they cannot explicitly capture the natural relationship between indirect social relations and latent user/item factors.

3.1 Disadvantages:

- The performance and accuracy is low
- There is no proper group recommendation

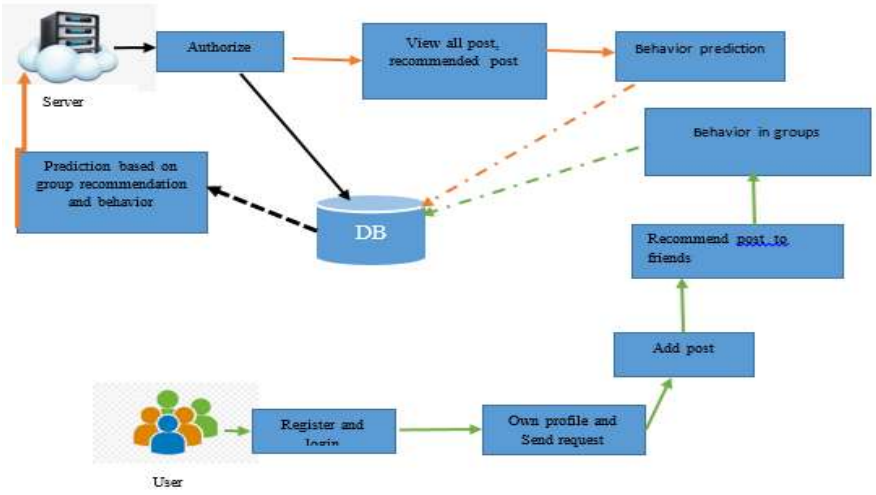
IV. PROPOSED SYSTEM

In this paper, the main contribution is to propose a new joint recommendation model taking advantage of the Indirect Social Relations detection and Matrix Factorization collaborative filtering on social network and rating behaviour information, which is called as InSRMF. In our work, the user latent factors can simultaneously and seamlessly capture user's personal preferences and social group characteristics. To optimize the InSRMF model, we develop a parallel graph vertex programming algorithm for efficiently handling large scale social recommendation data. A unified social recommendation model is proposed in this paper. It aims to sufficiently mine the indirect social relationships from both social information and user behavior data, exploit the fact the social relationship and user behavior depend on each other. The static social information and rating information are taken as the input of the proposed recommendation framework, and the indirect social relationships (user communities) and latent factors are iteratively identified. Experiments based on four real-world datasets (Ciao, Epinions, Douban and Yelp) are conducted to demonstrate the performance of the proposed model. The experimental results have shown that InSRMF has ability to mine the proper indirect social relations and improve the recommendation performance

4.1 Advantages

- The group recommendation is high Performance and Accuracy.
- To effectively combine the social overlapping community detection and matrix factorization collaborative filtering
- There is no leakage of data.

V. SYSTEM ARCHITECTURE



VI. CONCLUSION

In this paper, we focus on the community-based social recommendation which is rarely studied but attracts attention recently. To leverage the recommendation performance, we proposed a joint model InSRMF to effectively combine the social overlapping community detection and matrix factorization collaborative filtering. Meanwhile, an efficient parallel graph computing algorithm is designed to solve the model. The experiments on benchmark datasets showed that InSRMF is consistently superior to the stateof-the-art approaches in the settings, including recommendation on All Users, Near-cold-start Users, Pure-cold-start Users, Longtail Items and users with different social degrees

VII. APPLICATION AND FUTURE ENHANCEMENT

This application has been used for all other fields recommendation system to know about correct information Thus, we tend to further improve the proposed model by considering dynamical temporal information of social relations and rating information.

Meanwhile, we could integrate other available multiple resources such as item content, user-user interaction information, etc., like Context to design more effective and explainable recommendation systems

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