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Enhanced Recommender Systems with Diffusion Dynamics and Machine Learning

by Ximeng Wang

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Associate Professor Guangquan Zhang
and Distinguished Professor Jie Lu

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Certificate of Original Authorship

I, *Ximeng Wang*, declare that this thesis is submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the School of Computer Science at the Faculty of Engineering and Information Technology at the University of Technology Sydney. This thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis. I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of the requirements for a degree at any other academic institution except as fully acknowledged within the text. This thesis is the result of a Collaborative Doctoral Research Degree program with Beijing Jiaotong University. This research is supported by the Australian Government Research Training Program.

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ABSTRACT

Recommender systems are an effective tool for solving problems with information overload. As such, they have not only received much attention from academia, they have also been widely used in industry. However, although recommender systems have seen many significant research outcomes, they also face some challenges and problems.

This thesis focuses on enhancing recommender systems through the use of diffusion dynamics and machine learning, and solves four problems faced by existing recommendation methods: 1) Can diffusion-based recommendation methods get a better balance between accuracy and diversity; 2) How can trust diffusion processes be modeled in social networks and how can social information be introduced into diffusion-based recommendation methods; 3) Can opinion dynamics be integrated with machine learning to make better recommendations; and 4) How can the issue of preference conflicts in group recommender systems be alleviated such that the recommendations generated meet the requirements of most of the users in a group.

To address Problem 1), this thesis presents a mixed similarity diffusion process that integrates two kinds of similarity measures from both explicit and implicit feedback data. It also considers the degree of balance for different kinds of nodes in a bipartite network. This new diffusion process enhances both the accuracy and diversity of the recommendations.

To address Problem 2), a trust diffusion process is simulated via a trust network that introduces explicit trust into the diffusion process, while the similarity between users indicates implicit trust. Moreover, a special resource allocation process, designed for a tripartite network, combines both kinds of trust to model user preferences in a more exact manner.

To address Problem 3), a social recommendation model is used to integrate opinion dynamics and user influence into a matrix factorization framework. The model characterizes the impact of neighbors on user opinions through evolutionary game theory and uses a payoff matrix to improve the training process of the matrix factorization. In addition, user influence that originates from the trust network is added to the proposed recommendation model.

To address Problem 4), a virtual coordinator combined with group recommendation solves preference conflicts through a negotiation process. The virtual coordinator brings a global perspective to optimizing the evaluation processes of individual user preferences in a group in order to create a balanced set of group recommendations. Additionally, personal influence is inferred from the trust relations to define the impact of the virtual coordinator on each group member.

To conclude, this thesis proposes a set of recommendation methods for both personalized and group recommendation that go some way to solving current challenges in recommender systems.

LIST OF PUBLICATIONS

1. **Wang, X.**, Liu, Y., Lu, J., Xiong, F. & Zhang, G., 2019, 'TruGRC: Trust-aware group recommendation with virtual coordinators', *Future Generation Computer Systems*, vol. 94, pp. 224-236.

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