Editorial

The Era of Intelligent Recommendation: Editorial on Intelligent Recommendation with Advanced AI and Learning

Shoujin Wang
Macquarie University

Gabriella Pasi
University of Milano-Bicocca

Liang Hu
University of Technology Sydney

Longbing Cao
University of Technology Sydney

It is our pleasure to share with you this special issue on intelligent recommendation with advanced artificial intelligence (AI) and learning, which includes eight articles published in the September/October issue of IEEE Intelligent Systems (IS).

After our announcement in early August 2019 for this special issue, we received 40 submissions, only 8 ones out of which are accepted to be included in this special issue. After a long period of hard-work of review from anonymous reviewers and careful revisions from the authors, we finally achieve the current versions of the accepted papers published in this issue. First, we would like to sincerely thank all the contributors and the anonymous reviewers for their great efforts made on this special issue. Second, we express our sincere gratitude to the IS team led by Professor Venkatramanan Subrahmanian for their support and help to ensure the timely publication of this issue.

Digital Object Identifier 10.1109/MIS.2020.3026430
Date of current version 29 October 2020.

As we know, in this decade, the renaissance of AI has reshaped the world. Recommender systems as the most practical AI technology have been integrated into more and more traditional and emerging areas, including business, finance, health, traffic, education, and so on.[1] In this age, data science, advanced AI, and learning techniques constitute the foundations to build advanced intelligent recommendations.

This is the age of AI, this is the age of Big Data, and this is also the age of Recommendation. Most new ideas and advanced AI technology for recommendation are still in their infancy or integration stage. In the past few months, several specialized recommendation issues have been published to discuss complex data, advanced AI, and intelligent recommendation.[2,3] In a complementary way, we hope that this special issue is able to bring something new and different to inspire readers to address both existing and emerging problems in building recommender systems.

As one of the most important applications of AI, data science, and advanced analytics theories and techniques, recommendation has been deeply integrated into our daily life. Advanced learning, and AI techniques constitute the formal background employed to build advanced intelligent recommendations. On the other side, advanced AI and learning have been driving a variety of intelligent recommendation issues, including intent and preference modeling, non-IID recommendations, personalized recommendations, real-time recommendations, next-best recommendations, cross-domain recommendations, etc., in a context-aware, real-time, sequential, and user/product/domain-specific manner.

This special issue aims to collect the state-of-the-art theories, tools, and applications for intelligent recommendation, enabled by advanced learning and AI techniques, data science, and advanced analytics. We have eight articles that focus on these particular issues for this September/October issue. In the following, we give a brief introduction to each of them.

The first article entitled "MGNN: Mutualistic Graph Neural Network for Joint Friend and Item Recommendation" by Xiao *et al.*[4] proposes a holistic approach to predict users' preferences on friends and items jointly and thus generates more accurate recommendations on both friends and items for the users. This enables the modeling of users' consumption preferences and social influence simultaneously. The proposed approach is then specified to a graph neural network which incorporates a mutualistic mechanism to model the mutual reinforcement relationship between users' consumption behaviors and their social behaviors. The effectiveness of the approach has been demonstrated by the experiments conducted on two real-world datasets.

The second article entitled "Personalized Geographical Influence Modeling for POI Recommendation" by Zhang *et al.*[5] focuses on addressing the challenge of effectively exploiting geographical information in point-of-interest (POI) recommendations. Accordingly, the authors propose a personalized geographical influence modeling (PGIM) to jointly learn users' geographical preferences and diversity preferences for POI recommendations. Three aspects, i.e., user global tolerance, user local tolerance, and spatial distance are taken into account to model users' geographical preferences. In addition, PGIM is able to make diversity-promoting recommendations by extracting user diversity preferences from interactions among users.

The third article entitled "Guidelines for the Analysis and Design of Argumentation-based Recommendation Systems" by Leiva *et al.*[6] focuses on argumentation-based recommender systems. Argumentation-based recommender systems utilize argumentation-based tools to generate and analyze arguments for recommending a specific item based on a user's preference. They can provide qualitative and quantitative analysis on the characteristics of the recommended items, making it possible to provide explanations for recommendations. In the article, the authors have developed a series of software engineering guidelines for the analysis and design of argumentation-based recommender systems.

The fourth article entitled "Collaborative Filtering with Ranking-based Priors on Unknown Ratings" by Chen *et al.*[7] focuses on the problem of how to set an appropriate

prior on those missing ratings in collaborative filtering recommender systems. Specially, instead of using prior ratings as most of the existing methods do, the authors propose a ranking-based prior by hypothesizing that each user's unknown ratings are close to each other. This prior can be actually seen as a regularizer to penalize the discrepancy of predicted ratings for any two unknown items of the same user. Accordingly, a generic collaborative filtering framework for explicit user feedback data is proposed and an efficient optimization algorithm for the corresponding parameter learning is developed. The evaluation on four real-world datasets demonstrates the superiority of the proposed method over the state-of-the-art baseline methods.

The fifth article entitled "HIGnet: Hierarchical and Interactive Gate Networks for Item Recommendation" by Zhong *et al.*[8] focuses on the effective exploitation of the semantic information from reviews to complement user-item interactions for more accurate item recommendations. Specifically, a novel Hierarchical and Interactive Gate Network (HIGnet) model for rating prediction is proposed. HIGnet models the local word information and global review semantics in a hierarchical manner. This enables the possibility to effectively exploit textual features of users/items and to capture complex semantic correlations between users and items at different levels of granularities. With the precisely modeling of low level textual features and high-level semantic correlations, HIGnet can make more accurate rating prediction. Experiments on five real-world datasets demonstrate its superiority over the state-of-the-art methods.

The sixth article entitled "Contextual Bandits with Hidden Features to Online Recommendation via Sparse Interactions" by Yang *et al.*[9] focuses on online recommendations in the case of sparse user-item interactions. In the article, the authors propose a novel approach to make online recommendations via sparse interactions. To be specific, a contextual bandit algorithm named hSAOR, is designed for online recommendations. hSAOR makes probabilistic estimations on whether a user is interacting with an item or not by employing the assumption that similar items are similarly attractive. The effectiveness of hSAOR has been demonstrated by both theoretical analyses and experimental results.

The seventh article entitled "Semi-Discrete Matrix Factorization" by Wu *et al.*[10] focuses on the improvement of prediction efficacy of discrete matrix factorization. In the article, the authors propose a semidiscrete matrix factorization model to combine the predicting efficacy of matrix factorization and the inferring efficiency of discrete matrix factorization. The proposed approach can overcome the problem of encoding loss of the discrete matrix factorization caused by the oversimplified modeling on the original data geometry. An efficient optimization algorithm to estimate parameters of the proposed semidiscrete matrix factorization model is developed. The empirical evaluations on three real-world datasets demonstrate the superiority of the proposed model.

The eighth article entitled "Collaborative Generative Hashing for Marketing and Fast Cold-start Recommendation" by Zhang *et al.*[11] focuses on speeding up the online recommendations while alleviating the cold-start problem. In the article, the authors propose a collaborative generated hashing (CGH) framework to improve the efficiency of recommendations by denoting users and items as binary codes to enable the utilization of fast hashing search techniques for speeding up online recommendations. The advantages of the proposed framework have been demonstrated by the experiments conducted on two real-world datsets. In addition, the feasibility of CGH in marketing application has been analyzed.

REFERENCES

1. S. Wang, L. Hu, Y. Wang, L. Cao, Q. Z. Sheng, and M. Orgun, "Sequential recommender systems: Challenges, progress and prospects," in *Proc. 28th Int. Joint Conf. Artif. Intell.*, 2019, pp. 6332–6338.
2. B. Guo, X. Xie, L. Yao, Y. Li, C. Mascolo, and X. Hu, "Special issue on recommender system," *CCF Trans. Pervasive Comput. Interact.*, vol. 1, pp. 237–239, 2019.

3. D. Jannach, B. Mobasher, and S. Berkovsky, "Research directions in session-based and sequential recommendation," *User Model. User-Adapted Inter.*, vol. 30, no. 4, pp. 609–616, 2020.
4. Y. Xiao, L. Yao, Q. Pei, X. Wang, J. Yang, and Q. Z. Sheng, "MGNN: Mutualistic graph neural network for joint friend and item recommendation," *IEEE Intell. Syst.*, to be published.
5. Y. Zhang *et al.*, "Personalized geographical influence modeling for poi recommendation," *IEEE Intell. Syst.*, to be published.
6. M. Leiva, M. C. Budan, and G. I. Simari, "Guidelines for the analysis and design of argumentation-based recommendation systems," *IEEE Intell. Syst.*, to be published.
7. J. Chen, D. Lian, and K. Zheng, "Collaborative filtering with ranking-based priors on unknown ratings," *IEEE Intell. Syst.*, to be published.
8. M. Zhong *et al.*, "Hignet: Hierarchical and interactive gate networks for item recommendation," *IEEE Intell. Syst.*, to be published.
9. S. Yang, H. Wang, C. Zhang, and Y. Gao, "Contextual bandits with hidden features to online recommendation via sparse interactions," *IEEE Intell. Syst.*, to be published.
10. J. Wu, F. Luo, Y. Zhang, and H. Wang, "Semi-discrete matrix factorization," *IEEE Intell. Syst.*, to be published.
11. Y. Zhang, I. W. Tsang, and L. Duan, "Collaborative generative hashing for marketing and fast cold-start recommendation," *IEEE Intell. Syst.*, to be published.