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Japan Advanced Institute of Science and Technology

Dissertation title: **A Study on Recommender Systems Based on Dempster-Shafer Theory**

Doctoral student: Van-Doan Nguyen (1460003)
Supervisor: Associate Professor Van-Nam Huynh

ABSTRACT

Recommender systems (RSs) have been developing rapidly since they were introduced in 1990s; and in practice, these systems have been applied in a variety of e-commerce applications. Usually, RSs provide rating domains representing as finite sets and allow users (customers) to evaluate items (products or services) with hard ratings which are known as single values in the sets. However, user preferences are subjective and qualitative; therefore, in some scenarios, representing user preferences as hard ratings is not suitable. Moreover, most previous studies on recommendation techniques have unfortunately neglected the important issue of imperfect information which may be present due to ambiguities and uncertainties in user ratings.

More recently, using soft ratings represented as subsets of a rating domain is considered to be a strategy to model not only subjective and qualitative information but also imperfect information about user preferences in RSs. According to the literature, RSs offering soft ratings are developed based on Dempster-Shafer theory (DST) which is known as one of the most general theories for modeling imperfect information. Furthermore, these days, communication and collaboration in social networks have become more and more convenient and frequent, and social relations in social networks can naturally influence individual behaviors as well as decisions including the ones on buying items. In this research, we have developed two novel collaborative filtering RSs based on DST, which exploit community context information and community preferences extracted from social networks for improving accuracy of recommendations. One of the developed systems is able to deal with the sparsity problem, and the other can overcome both the sparsity and cold-start problems.

In RSs based on DST, context information, community context information or community preference is employed for predicting unprovided ratings, and then both predicted and provided ratings are used for computing user-user similarities. As predicted ratings are not one hundred percent accurate, while the provided ratings are actually evaluated by users, in this research, we have proposed a new method for computing user-user similarities, in which provided ratings are considered more significant than predicted ones.

As observed, Dempster's rule is currently applied for combining information about user preferences in RSs based on DST. However, when using this method, the combined results usually contain many focal elements with very low probabilities and a few focal elements with high probabilities. The focal elements with very low probabilities can lead to unsatisfactory

results in case of combining highly conflicting mass functions. Therefore, in this research, we have developed two new combination methods, called *2-probabilities focused* combination and *noise-averse* combination, which are capable of reducing the focal elements with very low probabilities. Moreover, Dempster's rule does not allow to combine totally conflicting mass functions which are common in RSs based on DST due to the diversity of users; thus, we have also developed two new mixed combination methods that support combining totally conflicting mass functions. In fact, the new combination methods developed in this research can be employed as useful tools for fusing information about user preferences from different sources in RSs based on DST.

Keywords: Recommender System, Dempster-Shafer Theory, Social Network, Information Fusion, Uncertain Reasoning.