A Particle Swarm Optimization Approach to Fuzzy Case-based Reasoning in the Framework of Collaborative Filtering

Shweta Tyagi, Shyama Prasad Mukherji College (for women), University of Delhi, New Delhi, India
Kamal K. Bharadwaj, School of Computer and Systems Sciences, Jawaharlal Nehru University, New Delhi, Delhi, India

ABSTRACT

The particle Swarm Optimization (PSO) algorithm, as one of the most effective search algorithm inspired from nature, is successfully applied in a variety of fields and is demonstrating fairly immense potential for development. Recently, researchers are investigating the use of PSO algorithm in the realm of personalized recommendation systems for providing tailored suggestions to users. Collaborative filtering (CF) is the most promising technique in recommender systems, providing personalized recommendations to users based on their previously expressed preferences and those of other similar users. However, data sparsity and prediction accuracy are the major concerns related to CF techniques. In order to handle these problems, this paper proposes a novel approach to CF technique by employing fuzzy case-based reasoning (FCBR) augmented with PSO algorithm, called PSO/FCBR/CF technique. In this method, the PSO algorithm is utilized to estimate the features importance and assign their weights accordingly in the process of fuzzy case-based reasoning (FCBR) for the computation of similarity between users and items. In this way, PSO embedded FCBR algorithm is applied for the prediction of missing values in user-item rating matrix and then CF technique is employed to generate recommendations for an active user. The experimental results clearly reveal that the proposed scheme, PSO/FCBR/CF, deals with the problem of sparsity as well as improves the prediction accuracy when compared with other state of the art CF schemes.

Keywords: Case-Based Reasoning, Collaborative Filtering, Fuzzy Similarity, Particle Swarm Optimization, Recommender Systems

1. INTRODUCTION

Collaborative filtering (CF) (Adomavicius & Tuzhilin, 2005; Koren, 2008) recommendation technique predicts the interest of an active user by collecting rating information from other similar users or items. These techniques have been extensively applied in some popular commercial systems, such as Amazon (Linden et al., 2003), AdaptiveInfo.com (Billsus et al., 2002). More precisely, CF approach finds a set of similar users based on their preferences...
for items and recommends those items which have preferred by similar users. The CF based recommendation methods are based on two types of approaches: model-based approaches and memory-based approaches (Adomavicius & Tuzhilin, 2005; Breese et al., 1998). The model-based CF is based on a compact model inferred from the database, which is then used to make rating predictions. The model can be learned from the underlying data using data mining or machine learning techniques. For example, Bayesian belief nets (BNs) CF models (Breese et al., 1998; Miyahara & Pazzani, 2000; Su & Khoshgoftaar, 2006), clustering CF models (Ungar & Foster, 1998; Chee et al., 2001; Xue et al., 2005), and latent semantic CF models (Hofmann, 2004) are the well-known model-based CF techniques. Memory-based approaches utilize the entire user-item database to generate a prediction based on user or item similarity. These methods are particularly deployed into commercial systems such as http://www.amazon.com/ and Barnes and Noble, because they are easy-to-implement and highly effective (Hofmann, 2004; Linden et al., 2003). Further, two types of memory-based methods have been studied: user-based (Breese et al., 1998; Xue et al., 2005) and item-based (Linden et al., 2003). User-based methods try to find the similar users for an active user and then employ the ratings from those similar users to predict the ratings for the active user. Whereas, item-based methods attempt to find similar items for each active item (the item not rated by the active user) and then utilize the ratings of those similar items to predict the ratings of the active item.

The major concern of memory-based approaches is the data sparsity of the user-item rating matrix. Generally, the user-item rating matrix is quite sparse, which directly leads to the poor quality of predictions. In literature several algorithms have been developed to address the issue of data sparsity in CF based recommendation techniques (Billsus et al., 2002; Breese et al., 1998; Xue et al., 2005; Tyagi & Bharadwaj, 2010; Tyagi & Bharadwaj, 2012). Xue et al. (2005) proposed a scalable CF approach using cluster-based smoothing to tackle the problem of sparsity. Wang et al. (2006) suggested a generative probabilistic framework to exploit more of the data available in the user-item rating matrix by fusing all ratings with a predictive value for making recommendations. Ma et al. (2007) designed an effective scheme which predicts the missing data and then generates recommendations.

In this article a novel approach is proposed to alleviate the problem of sparsity in the framework of CF. The main emphasis of the proposed work is on the use of particle swarm optimization (PSO) algorithm (Kennedy & Eberhart, 1995) to learn the weights of different attributes used to embody the preferences of a user. This enables the fuzzy case based reasoning (CBR) system to represent the user (case) more precisely and to retrieve more appropriate case or cases. In this way, the proposed approach employs PSO based Fuzzy CBR called FCBR for filling missing values in the sparse user-item rating matrix and then generates recommendations by applying CF.

The remainder of this paper is organized as follows. In Section 2, we present an outline of CBR in the framework of CF, a brief introduction of FCBR and a general background of PSO algorithm. Section 3 provides the detail description of the architecture of proposed PSO/FCBR/CF method. The results of an empirical analysis are discussed in Section 4, followed by a conclusion in Section 5.

2. RELATED WORK

Now a day, CF based RSs are bringing benefits to companies by providing fast and accurate recommendations to their customers. Production of high quality recommendations depends on how well these systems address their shortcomings. In the domain of CF, a remarkable research work has been incorporated to improve the performance of CF as well as to address the challenges of CF.

2.1. CBR in the Framework of CF

Reisbeck and Schank (1989) coined the classic definition of CBR. They illustrated that CBR
A Study of the Systemic Relationship Between Worker Motivation and Productivity
J. J. Haefner and Christos Makrigeorgis (2012). *Knowledge and Technology Adoption, Diffusion, and Transfer: International Perspectives* (pp. 56-72).
www.igi-global.com/chapter/study-systemic-relationship-between-worker/66935?camid=4v1a