International Journal of Decision Support System Technology
Volume 9 • Issue 4 • October-December 2017

A Recommender System Based on Multi-Criteria Aggregation

Soumana Fomba, University of Science, Technique and Technologies of Bamako, Bamako, Mali & University of Toulouse, Toulouse, France

Pascale Zarate, University of Toulouse, Toulouse, France

Marc Kilgour, Wilfrid Laurier University, Waterloo, Canada

Guy Camilleri, University of Toulouse, Toulouse, France

Jacqueline Konate, University of Science, Technique and Technologies of Bamako, Bamako, Mali

Fana Tangara, University of Science, Technique and Technologies of Bamako, Bamako, Mali

ABSTRACT

Recommender systems aim to support decision-makers by providing decision advice. We review briefly tools of Multi-Criteria Decision Analysis (MCDA), including aggregation operators, that could be the basis for a recommender system. Then we develop a multi-criteria recommender system, STROMa (SysTem of RecOmmendation Multi-criteria), to support decisions by aggregating measures of performance contained in a performance matrix. The system makes inferences about preferences using a partial order on criteria input by the decision-maker. To determine a total ordering of the alternatives, STROMa uses a multi-criteria aggregation operator, the Choquet integral of a fuzzy measure. Thus, recommendations are calculated using partial preferences provided by the decision maker and updated by the system. An integrated web platform is under development.

KEYWORDS

Choquet Integral, MCDA, Recommender System

INTRODUCTION

Research in the field of multi-criteria decision aid (MCDA) (Roy, 1996) has provided models and principles for decision problems that are both flexible and robust. In particular, a decision on multiple criteria must take synergy into account: positive synergy among criteria means that the criteria are related in that they all tend to have large or small values at the same time; a negative synergy means that one criterion has a negative influence on the others. Indeed, the use of fuzzy measures (Sugeno, 1974) provided both flexibility and robustness, and their use in Choquet integrals (Choquet, 1953; Beliakov et al., 2008; Grabisch et al., 2009) effectively models the preferences of the decision-maker while taking into account both positive or negative synergies among criteria.

The quantitative approach forces a decision maker to think carefully about preferences over criteria. In addition, the decision maker must determine values for all alternatives on all criteria, which is often causes the greatest difficulties. These problems can be avoided by using a fuzzy measure

DOI: 10.4018/IJDSST.2017100101

to support decision-making based on a numerical representation that reflects the decision-maker's preference input.

The main objective of this article is the setting up of a Multicriteria recommendation system called STROMa. This system allows, for a decision problem and from a partial order established by the decision maker on a subset of alternatives, to determine the fuzzy measure digitally representing the decision maker's preferences.

Implementation of the Choquet integral as an aggregation operator is also discussed. This operator allows us to calculate the overall score of each alternative in order to establish a final ranking.

This paper is organized as follows. In the next section, we talk about related work on recommendation systems. The notation required to describe several aggregation operators and some axioms is introduced in the third section. The next section then describes the application of the Choquet integral to the evaluation of a fuzzy measure and its subsequent use to rank alternatives. In the fourth section, we present the web interface recommender system, STROMa, that we have developed and its limitations. In the final section, we offer some conclusions and an outlook.

RECOMMENDATION SYSTEMS

Recommendation systems are as interactive decision support systems to take into account evolving preferences of users with a view to make recommendations. There are three main families of recommendation systems:

- **Content-Based Recommendation:** Uses only object characteristics and user preferences to issue recommendations. This type of system is very effective when detailed information is available on the objects. Several such recommendation systems have emerged. For example, Martin et al. (2012) used a content-based referral system to help select a provider for a user based on their profile. Also, Eureka is a system available on CanalSat TV channels. It analyzes the programs watched by the user to find out what type of program he enjoys. The system of recommendation that we put in place called STROMa is also of this type. But this method also has disadvantages. To make recommendations in relation to user preferences, the user must be familiar with the system. Thus, during the initialization step of the preferences of the user, the system will not be able to make recommendations or these will be irrelevant;
- **Collaborative Recommendation:** Uses the preferences of all available users to make proposals (Adomavicius et al., 2005). The basic idea of this method is that if a user has tastes similar to other users, then he should appreciate the objects chosen by them. Unlike the content-based recommendation, the system does not need to have much information to offer objects to the user. But the collaborative recommendation also has drawbacks. In the case of a system with few users or if the user has atypical preferences, there may be no user with a similar behavior, in which case the recommendations are not relevant. Very large systems use the collaborative recommendation. For example, Twitter suggests to its users a list of people to follow;
- **Hybrid Recommendation:** Hybrid recommendation is a combination of content-based recommendation and collaborative recommendation. The aim is to eliminate the disadvantages of both approaches. The best-known hybrid recommendation system is the one used by Amazon (Linden et al., 2003). Thus, Lakiotaki et al. (2011) set up a recommender system for movies of the high-performance hybrid type, based on the disaggregation-aggregation approach. Nevertheless, an aggregation approach is interesting in order avoid to too much frequently ask questions to the user.

NOTATION AND AGGREGATION OPERATORS

We start by introducing some concepts. Let $X = \{a, b, \ldots\}$ be the set of alternatives (solutions), and let $N = \{1, \ldots, n\}$ be an index set representing the criteria.