Multicriteria customer satisfaction analysis with interacting criteria

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We are considering conjoint analysis [7], which is the problem of measuring and analyzing customer satisfaction, with the aim of representing positive and negative synergies between specific aspects of a product or a service.

In Multiple Criteria Decision Analysis (MCDA, for an updated state-of-the-art see [1]) positive and negative synergies between criteria are very often represented using the Choquet integral (for a survey about the use of Choquet integral in MCDA see [3]) which is an aggregation model that, among its other technical assumptions, has the requirement of a scale of measurement which is cardinal and common to all the aspects taken into consideration.

Since we want to deal with positive and negative synergies within conjoint analysis taking into account only ordinal qualitative aspects of the scales of criteria, we consider the multicriteria method MUSA (MUlticriteria Satisfaction Analysis) [8, 9]. This is a preference disaggregation method that, following the principle of ordinal regression analysis (inference procedure), defines a utility function representing the satisfaction level of a set of individuals (customers, employees, etc.) based on their values and expressed preferences collected in satisfaction survey's data. The main advantage of the MUSA method is that it fully considers the qualitative form of customers' judgments and preferences. Within MUSA, the positive and negative synergy is modeled using an approach proposed in the multicriteria method UTA^{GMS}-INT [5]. Instead of the Choquet integral aggregation model, UTA^{GMS}-INT considers only ordinal character of scales of considered criteria, avoiding any arbitrary transformation of the original ordinal scales into artificial cardinal scales.

The utility function considered in our model represents the utility of the known comprehensive satisfaction level of customer whose satisfaction on particular criteria (aspects) is also known.

To get a utility function that represents the utility of all customers with a minimal approximation error we need to solve a Mixed-Integer Linear Problem (MILP).

Such MILP gives as solution the utility function and two sets, Syn^+ and Syn^-, composed of couples of criteria, that interact, positively and negatively, respectively.

However, the two sets Syn^+ and Syn^- obtained from this MILP are not minimal, in the sense that there could be other sets Syn'^+ and Syn'^- of couples of interacting criteria that could represent the utility of all customers with the same approximation error but such that $Syn'^+ \subseteq Syn^+$ and $Syn'^- \subseteq Syn^-$, with at least one of the two inclusions being strict.

In order to determine two minimal sets Syn^+ and Syn^- of couples of interacting criteria while possibly accepting a small deterioration of the optimal approximation error of the previous MILP with a fixed tolerance parameter, another MILP has to be solved.

This second program gives as solution the utility function (possibly different from the utility function resulting from the previous program) and two minimal sets, Syn^+ and Syn^-, of positively and negatively interacting couples of criteria, respectively.

Let us remark that it is possible to detect the existence of alternative minimal sets Syn^+ and Syn^- satisfying the fixed tolerance constraint [5]. In case of a plurality of alternative minimal sets Syn^+ and Syn^-, it is interesting to compute the intersection of all the sets Syn^+ on one hand, and of all the sets Syn^- on the other hand, without deteriorating the approximation error. Notice that this interpretation of alternative minimal sets Syn^+ and

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Syn^- is analogous to the concept of reducts, as well as the intersection of all the sets Syn^+ on one hand, and of all the sets Syn^- on the other hand, is analogous to the concept of core in rough set theory [10].

Observe also that, since for a given tolerance parameter there can be many utility functions representing satisfaction of the customers, it is recommended to take into account the whole set of these utility functions adopting the robust ordinal regression methodology [2, 4, 6].

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