Modelling interactions on bipolar scales using robust ordinal regression: the UTA^{GSS} method

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Abstract

We are considering interactions between criteria in the framework of Multiple Criteria Decision Analysis (MCDA). The problem of representing interactions has been dealt with different methodologies, such as polynomial conjoint measurement, multilinear value functions, and nonadditive integrals, like Choquet integral and Sugeno integral. Recently Greco, Mousseau and Slowinski (GMS 2011) presented a decision model able to represent interaction by adding to the classical additive utility function some additional terms expressing a bonus or a penalty related to evaluations of pairs, triples and, in general, *n*-tuples of criteria. (GMS 2011) presents a method called UTA^{GMS}-INT in which the decision model is assessed using robust ordinal regression. This means that starting from some preference information given by the Decision Maker (DM), the set of compatible value functions is defined such that alternative *a* is necessarily weakly preferred to alternative *b* if *a* is at least as good as *b* for all compatible value functions, while *a* is possibly weakly preferred to *b* if *a* is at least as good as *b* for at least one compatible value function. The interactions modelled in (GMS 2011) are synergy and redundancy, which yield a bonus or a penalty, respectively, when values of the considered *n*-tuple of criteria improve together.

In this paper, we present a new method, called UTA^{GSS}, that extends the UTA^{GMS}-INT method by considering criteria values expressed on a bipolar scale. In this case, synergy and redundancy (i.e. bonus and penalty) depend on the relative position of values of the considered *n*-tuple of criteria with respect to a neutral level. Considering interactions on bipolar scales we are able to get a representation of DM's preferences, which is more faithful with respect to the information supplied by the DM. Moreover, if the DM explicitly articulates a bipolar interaction, then the set of compatible value functions becomes smaller than that obtained in case of analogous interactions on unipolar scales. Thus, in comparison with the UTA^{GMS}-INT method, the final result will give more space to necessary preference, and less space to possible preference. If the DM has no idea about the interactions, then we use a mixed integer linear program to determine sets of pairs of interacting criteria. UTA^{GSS} is the most flexible method able to represent the most complex interactions. In UTA^{GSS} it is possible but not necessary to consider bipolar scales for all criteria. To gain the highest degree of freedom we use the idea of bipolarity to distinguish between different areas of interaction effects. This allows considering different neutral levels for each pair of interacting criteria. In the special case, all neutral levels regarding interactions between two criteria are located at the worst

performance of the criteria, and then UTA^{GSS} produces exactly the same results as its predecessor UTA^{GMS}-INT, which is based on unipolar scales.

References

Greco, S., Mousseau, V., Slowinski, R., 2011. UTAGMS-INT: Robust Ordinal Regression of Value Functions Handling Interacting Criteria, *submitted*.