Examining Ranking Methods as Aggregation Functions

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Abstract. One of the main ways to analyze data is through data fusion. This method is commonly used in several situations, such as business analysis, to aggregate data for well-founded decision-making.
A key data fusion tool is the concept of aggregation function, introduced by Calvo et al.[1] in 2002 and further studied by Beliakov et al.[2] in 2007. These functions take n input values and combine them to return a single data point, exhibiting properties like monotonicity and preservation of boundary conditions. Additionally, they can fulfill other properties such as associativity, symmetry, and idempotence, making them valuable resources in data analysis. Similarly, the literature also considers pre-aggregation functions, behaving similarly to aggregation functions but verifying a more relaxed form of monotonicity (Lucca et al. 2015[3]).
Rankings are another widely used tool in data fusion, as they allow to fuse the opinion of different experts into one. They involve the creation of different ordered lists of data, which are then combined into a single one. It is common to obtain multiple rankings from the same dataset depending on different criteria.
The primary goal of this work is to study ranking aggregations under different conditions and assess whether they satisfy the properties of aggregation functions or, alternatively, pre-aggregation functions. This leads to the concept of ranking aggregation, facilitating the use of ranking algorithms similar to how aggregation functions have been utilized as they combine several inputs into a single one.
We explore the possibilities of various ranking aggregation methods, and we develop functions such as the function B_{num}, which aggregates m rankings of n real numbers using the Borda method. Its monotonicity has been thoroughly examined, leading to the conclusion that B_{num} is not strictly monotonically increasing. However, it does exhibit directional monotonicity.

Keywords: Rankings · Aggregation function · Preaggregation function · Directional monotonicity

Acknowledgments. Authors would like to express their gratitude to the Spanish Ministry of Science and Innovation (fund reference: PREP2022-000355. Project: MCINN-23-PID2022-139886NB-I00). Dr Javier Fumanal-Idocin's research is supported by the

European Commission and The University of Essex under a Marie Sklodowska-Curie action for the YUFE4postdoc programme.

References

1. Tomasa Calvo, Anna Kolesarova, Magda Komornıkova, and Radko Mesiar. Aggregation operators: properties, classes and construction methods. Aggregation operators: new trends and applications, pages 3–104, 2002.
2. Gleb Beliakov, Ana Pradera, and Tomasa Calvo. Aggregation functions: A guide for practitioners, volume 221. Springer, 2007
3. Giancarlo Lucca, Jose Antonio Sanz, Gracaliz Pereira Dimuro, Benjamin Bedregal, Radko Mesiar, Anna Kolesarova, and Humberto Bustince. Preaggregation functions: Construction and an application. IEEE Transactions on Fuzzy Systems, 24(2):260–272, 2015.