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A lexicographically optimal completion for pairwise comparison matrices with missing entries

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Abstract:
Estimating missing judgements is a key component in many multi-criteria decision making techniques, especially in the Analytic Hierarchy Process. Inspired by the Koczkodaj inconsistency index and a widely used solution concept of cooperative game theory called the nucleolus, the current study proposes a new algorithm for this purpose. In particular, the missing values are substituted by variables, and the inconsistency of the most inconsistent triad is reduced first, followed by the inconsistency of the second most inconsistent triad, and so on. The necessary and sufficient condition for the uniqueness of the suggested lexicographically optimal completion is proved to be a simple graph-theoretic notion: the undirected graph associated with the pairwise comparisons, where the edges represent the known elements, should be connected. Crucially, our method does not depend on an arbitrarily chosen measure of inconsistency as there exists essentially one reasonable triad inconsistency index.

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Full text