Automatic consensus models to balance consensus cost, consistency level and consensus degree with attitudinal trust mechanism

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Abstract. Consensus Reaching Processes (CRPs) constitute a fundamental mechanism to improve acceptance and reliability in Group Decision Making (GDM). Existing consensus approaches commonly focus on optimizing a single objective, either maximizing consensus degree, preserving consistency, or minimizing consensus cost. However, practical decision environments require balancing these conflicting factors simultaneously. This work published in Information Sciences [3], presents an attitudinal trust-based automatic consensus framework that supports adaptive preference adjustment during the CRPs. The proposal incorporates trust-aware aggregation to regulate the influence among decision makers and automatically determine preference adaptation strategies. Three optimization perspectives are considered according to different decision requirements: consistency-driven, consensus-driven, and cost-driven consensus generation. The proposed framework enables flexible consensus support while preserving decision quality and reducing excessive preference modifications.

Keywords: Group decision making, consensus reaching process, consistency level, consensus cost

1 Introduction

Group Decision Making (GDM) has become a widely adopted paradigm for solving complex problems involving multiple stakeholders and competing interests. Since direct aggregation of individual preferences may generate disagreement and reduce acceptance of collective outcomes, Consensus Reaching Processes (CRPs) are commonly incorporated before final decision selection [2].

Traditional consensus models mainly aim to increase consensus degree. Nevertheless, achieving agreement frequently requires modifying participants' original opinions, generating consensus costs and potentially reducing the internal

consistency of preference structures. Consequently, consensus degree, consistency level, and consensus cost become three interconnected dimensions that jointly determine the quality and acceptability of decision outcomes.

Although previous studies have independently investigated consistency-driven and minimum-cost consensus mechanisms [1, 4], limited attention has been devoted to balancing these objectives simultaneously. To address this limitation, this work proposes an attitudinal trust-based automatic consensus framework capable of adaptively regulating preference adjustments according to trust relationships among decision makers.

2 Proposal

The proposed framework considers a GDM environment in which decision makers express their evaluations through fuzzy preference relations. After preference collection, consensus and consistency indicators are computed to identify participants requiring preference adjustment.

To support adaptive consensus generation, the proposal introduces an Attitudinal Trust Degree (ATD) mechanism to determine the influence of decision makers during preference aggregation. Trust levels are estimated according to preference similarity and controlled through an attitudinal parameter representing different trust behaviours.

Preference adjustment is generated automatically through the following mechanism:

$$\bar{R}^h = (1-\delta)R^h + \delta \sum_{v=1}^{f} w_{\sigma(v)}^{ATD} R^v, \tag{1}$$

where R^h and $\bar{R}^h$ denote the original and adjusted preference relations, $\delta \in [0, 1]$ is the adjustment parameter that quantifies the change from original preference to preferences of other decision makers, and w^{ATD} represents the trust-based aggregation weights.

The framework supports three complementary optimization perspectives (see Fig. 1):

1. Consistency-Driven Consensus Model (SIS-DRI), prioritizes preserving and improving the consistency level of adjusted preference relations while ensuring that consensus reaches acceptable levels and adjustment costs remain controlled. This model is particularly suitable for decision scenarios where maintaining coherent and rational preference structures is more important than achieving maximum agreement.
2. Consensus-Driven Consensus Model (SEN-DRI), aims to maximize the overall group consensus degree while maintaining acceptable preference consistency and preventing excessive preference modifications. This model is appropriate for collaborative environments where stakeholder alignment and collective acceptance are the primary objectives.

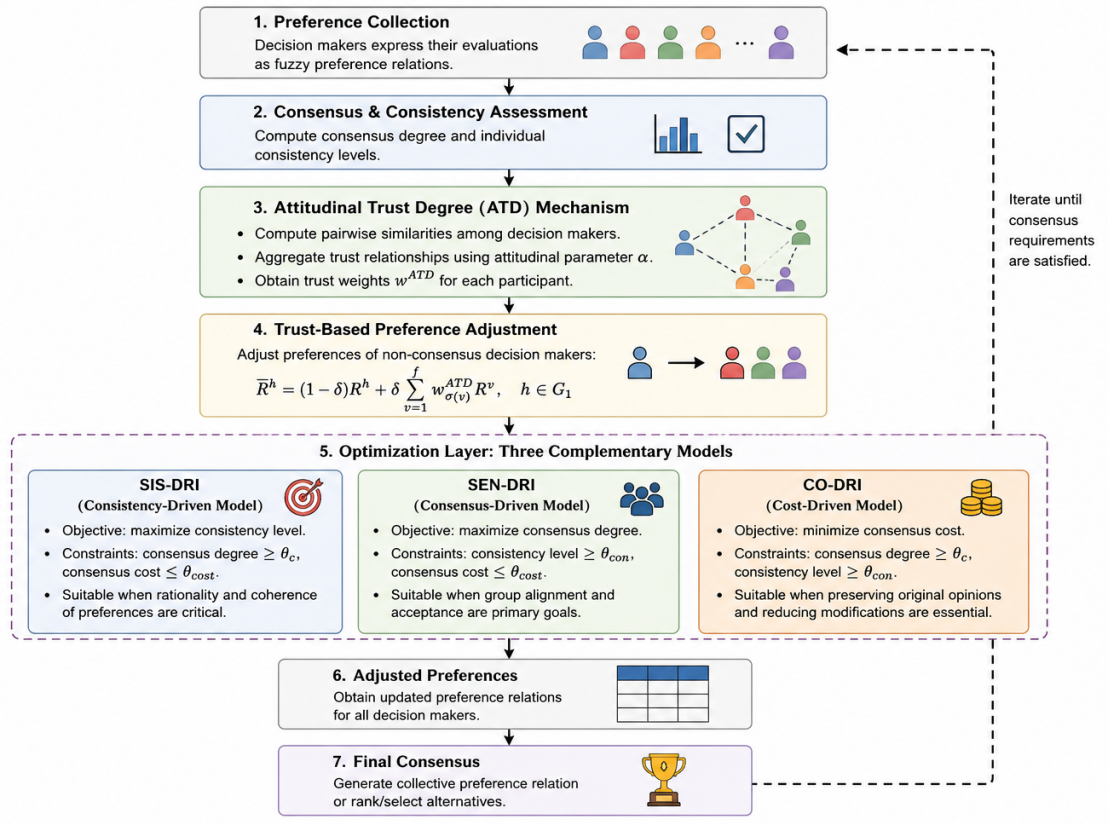


Fig. 1. Attitudinal trust-based automatic consensus framework

3. Cost-Driven Consensus Model (CO-DRI), minimizes the consensus cost associated with preference adjustments while guaranteeing minimum requirements on both consensus and consistency levels. This model is especially useful in situations where preserving decision makers' original opinions and reducing resistance to preference changes are critical.

Through the optimization of adjustment intensity and attitudinal trust parameters, the framework transforms consensus generation into an adaptive mechanism capable of prioritizing reliability, agreement, or adjustment minimization depending on decision requirements.

The resulting architecture supports configurable and automatic consensus generation and can be integrated into decision support systems for collaborative decision-making scenarios.

3 Conclusions

This work presented an attitudinal trust-based automatic consensus framework to balance consensus degree, consistency level, and consensus cost in consensus reaching processes. Unlike conventional consensus approaches focused on isolated objectives, the proposed framework introduces adaptive preference adjustment mechanisms guided by trust relationships and optimization strategies. The proposal enables flexible consensus generation according to different decision priorities and provides a basis for future developments on explainable and human-centric consensus support systems.

Acknowledgments. Este trabajo ha sido parcialmente financiado por el Ministerio de Ciencia, Innovación y Universidades a través del proyecto de generación de conocimiento (PID2024-161073NB-I00).

References

1. Leyva-López, J.C.: A consistency and consensus model for group decision support based on the outranking approach (2024)
2. Li, Z., Zhang, Z.: Threshold-based value-driven method to support consensus reaching in multicriteria group sorting problems: A minimum adjustment perspective. IEEE Transactions on Computational Social Systems **11**(1), 1230–1243 (2024)
3. Liu, Y., Wang, Y., Rosa M., R., Zhang, Zhen, M.L.: Automatic consensus models to balance consensus cost, consistency level and consensus degree with attitudinal trust mechanism. Information Sciences **716**, 122222 (2025)
4. Wu, T., Liu, X., Gong, Z., Zhang, H., Herrera, F.: The minimum cost consensus model considering the implicit trust of opinions similarities in social network group decision-making. International Journal of Intelligent Systems **35**(3), 470–493 (2020)