# Compromise Fuzzy Ranking: a novel method for reaching consensus in complex multi-criteria decision problems

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**Abstract.** In complex decision-making environments involving multiple conflicting criteria, the need for robust and insightful evaluation methods is increasingly critical. This study aims to address the inconsistencies among Multi-Criteria Decision Analysis (MCDA) methods, which often yield divergent rankings for the same problem. To overcome this challenge, we propose a novel Compromise Fuzzy Ranking (CFR) method that integrates both positional rankings and preference scores, offering a more balanced and informed consensus in decision-making. The CFR method is evaluated through theoretical analysis and simulation studies, demonstrating its ability to produce more consistent and interpretable results compared to traditional compromise approaches. The key benefit of CFR lies in its capacity to capture the complementary strengths of different ranking perspectives, thereby enhancing the quality, transparency, and reliability of decision support systems.

**Keywords:** multi-criteria decision analysis · compromise solution · fuzzy ranking

## 1 Introduction

In the face of ever-growing complexity in decision-making scenarios, the need for knowledge-driven approaches became significantly more relevant [26]. As contemporary challenges demand detailed and robust assessments, information systems emerge as indispensable tools designed to streamline decision processes and enhance their reliability [13]. Navigating the complexities of today's decision-making problems, considering multiple variables, conflicting objectives, and the changing needs of decision-makers highlights the urgent need for robust methodologies capable of dealing with complexities and providing practical insights [17].

Central to such systems are Multi-Criteria Decision Analysis (MCDA) methods, which provide a structured evaluation approach and framework tailored to guide a comprehensive decision support process [3]. As part of the development

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of the field of operations, many assessment techniques have been developed to enrich and improve the way in which decision options are assessed [14]. The variety of MCDA methods provides a range of benefits and presents some challenges in designing decision systems. While offering various evaluation options, it also introduces a selection problem, making it difficult to determine the most reliable evaluation for a given problem. To deal with this complexity, a common strategy is to use multiple MCDA methods, each offering a distinct perspective of the decision space [6, 23].

However, this multi-faceted approach presents some challenges. Individual MCDA methods often produce divergent rankings, each representing a unique problem interpretation [20, 27]. Resolving these discrepancies requires the use of compromise solution methods aimed at combining the divergent rankings into a coherent total and developing a consensus among the conflicting viewpoints [11]. Established techniques such as Borda, Copeland, Rank position, Half-Quadratic [15], and Iterative Compromise Ranking Analysis (ICRA) [16] play an important role in this process. However, while effective in their performance, these methods have limitations.

Compromise solution methods use two main assumptions in the consensus calculation process. Some methods are directed towards a strict dependence on positional rankings from MCDA methods [7]. Others are based on using preference scores from multi-criteria techniques [16]. In contrast, available and popular consensus techniques ignore the potential synergy between these approaches. While the positional ranking clearly indicates the proposed order of decision variants and is straightforward to interpret, it does not capture information about minor differences in evaluating alternatives [9]. Preference scores, on the other hand, are more difficult to interpret and require the decision-maker to have a certain knowledge of the assumptions of MCDA methods, while they allow for a more precise representation of differences in evaluations. Combining these approaches in trade-off calculations can provide decision support systems with access to more informed recommendations.

Given the identified research gap, this paper introduces a novel Compromise Fuzzy Ranking (CFR) method to improve consensus in multi-criteria evaluations by jointly utilizing positional rankings and preference scores. The main objective of this study is to fill the existing gap in current approaches for determining compromise solutions by incorporating both ranking positions and preference scores, providing a more comprehensive and balanced decision-making framework. Unlike traditional compromise methods that typically focus on one aspect, CFR integrates both perspectives in a unified framework, offering a more detailed and nuanced assessment. The key contributions are: 1) Proposal of the CFR method for achieving consensus in complex decision problems; 2) Integration of positional and preference-based information to enhance the depth and clarity of recommendations; 3) Validation through simulations and theoretical examples, showing improved consistency and insight compared to selected compromise methods.

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The rest of the paper is organized as follows. Section 2 presents the work related to practical applications of compromise methods. Section 3 describes the preliminaries of the fuzzy ranking procedure and introduces the Compromise Fuzzy Ranking method. Section 4 shows the study case with simulation runs and two theoretical examples to verify the performance of the proposed method in comparison with selected aggregation procedures. Section 5 discusses the obtained results. Finally, Section 6 draws conclusions from the research and indicates future directions.

## 2 Related works

Advancements in decision support have led to the development of a wide range of MCDA methods that assist in evaluating alternatives across complex criteria. With the introduction of new normalization techniques, distance metrics, and defuzzification methods, even a single MCDA method can yield varied results depending on its configuration. Consequently, decision models often incorporate multiple MCDA methods to enhance assessment reliability. However, benchmarking studies have shown that applying different methods to the same decision problem frequently results in inconsistent rankings, posing a challenge in consolidating conflicting outcomes.

Sałabun et al.[20] benchmarked the performance of methods such as Technique for the Order of Prioritisation by Similarity to Ideal Solution (TOPSIS), VIseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR), COmplex PRoportional ASsessment (COPRAS), and Preference Ranking Organization METHod for Enrichment of Evaluations II (PROMETHEE II) across varying problem sizes. Podvezko[18] compared SAW and COPRAS, while Ceballos et al. [5] analyzed TOPSIS, VIKOR, and Multi-Objective Optimization on the basis of a Ratio Analysis plus the full MULTIplicative form (MULTIMOORA). These studies consistently highlight that using multiple MCDA methods within the same problem can yield notably different rankings, underlining the importance of method selection and the need for mechanisms to resolve ranking conflicts.

To address this challenge, compromise solution methods have emerged, aiming to consolidate multiple rankings into a single consensus. For instance, Paradowski et al. proposed the ICRA method [16]. Wu et al. used an improved Borda method in linguistic group decision-making [24]. Mohammadi and Rezaei introduced an ensemble approach using Half-Quadratic (HQ) theory, providing not only consensus rankings but also insights into trust levels and the importance of each method [15]. Xiao et al. applied a Dominance-Directed Graph (DDG) approach [25], while Altuntas et al. utilized the Borda count and Rank position method to indicate the consensus ranking obtained from the three applied MCDA techniques [1]. Şahin employed the Copeland method to derive compromise rankings from different objective and subjective evaluations [19]. Other approaches for achieving consensus among conflicting objectives include the use of fuzzy logic [8], hesitant fuzzy sets [10], and fuzzy outranking methods [4]. However, these techniques primarily focus on facilitating agreement within group

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decision-making contexts and do not address the compromises needed between different MCDA methods.

Despite their usefulness, existing compromise methods have limitations. Many rely solely on the frequency of an alternative's ranking position, meaning even a slight majority can disproportionately influence the final outcome. This can lead to misleading conclusions, as these approaches often ignore valuable information embedded in preference scores. Most compromise methods consider either positional rankings or preference scores—but not both—resulting in an information gap that limits the depth and reliability of the final recommendation. This gap raises a critical question: Can integrating both positional rankings and preference scores lead to more informed and insightful compromise solutions? Addressing this question is central to the development of improved decision support tools that more fully reflect the complexity and nuance of real-world decision problems.

## 3 Preliminaries

### 3.1 Fuzzy ranking procedure

The fuzzy ranking concept presents an approach for establishing positional ranking with fuzzy sets and was presented in [22]. It assesses the frequency with which each alternative holds specific rank positions, facilitating the establishment of membership degrees. These degrees indicate the level of certainty in allocating an alternative to a given rank. Consequently, a two-dimensional matrix emerges, depicting the certainty of recommendations across various positions. This enables decision-makers to better understand the uncertainty and trustworthiness associated with these placements. The formal representation of this matrix, indicating the frequency of each alternative's ranking position, is defined as (1):

$$M = \begin{array}{c} \\ R_1 \\ R_2 \\ R_3 \\ \dots \\ R_m \end{array} \begin{array}{c} \begin{array}{ccccc} A_1 & A_2 & A_3 & \dots & A_m \end{array} \\ \begin{bmatrix} p_{11} & p_{21} & p_{31} & \dots & p_{m1} \\ p_{12} & p_{22} & p_{32} & \dots & p_{m2} \\ p_{13} & p_{23} & p_{33} & \dots & p_{m3} \\ \dots & \dots & \dots & \dots & \dots \\ p_{1m} & p_{2m} & p_{3m} & \dots & p_{mm} \end{bmatrix} \end{array} \tag{1}$$

where $p_{ij}$ represents the frequency of placing $i-th$ alternative within $j-th$ position in ranking.

Furthermore, two essential conditions are fulfilled by the matrix $M$. The first condition guarantees that the sum of values in each column equals 1, indicating the comprehensive coverage of ranking positions for a specific alternative (2).

$$\sum_{i=1}^{m} p_{ci} = 1 \tag{2}$$

where $c$ represents the column's index from the matrix and $m$ represents the number of alternatives. The second condition indicates that the sum of values

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in each row falls within the range [0, $m$], illustrating the frequency of placing alternatives across subsequent ranking positions (3).

$$0 < \sum_{i=1}^{m} p_{ir} < m \tag{3}$$

where $r$ represents the rows' index from the matrix and $m$ represents the number of alternatives.

### 3.2 Compromise Fuzzy Ranking

After computing the fuzzy ranking for each alternative based on the fuzzy ranking method described above, the next step involves aggregating these individual rankings to obtain a consolidated ranking representing the group's consensus. The Compromise Fuzzy Ranking method combines the fuzzy rankings of all alternatives into a single ranking that reflects the overall preferences of the decision-makers. Two variants of the CFR method are introduced. The first includes only positional rankings in calculating the compromise, while the second combines positional rankings with preference scores obtained from the applied MCDA methods. The formal notations of the two proposed approaches are described below.

**Positional ranking** To determine a consensus ranking, the first variant of the CFR method uses positional rankings obtained from the applied MCDA methods. This approach is based on determining the weighted rank, which is calculated by multiplying each row of the fuzzy ranking matrix by its corresponding position to assign weights to each alternative's ranking position. The calculation formula for this variant is expressed as (4):

$$\mathrm{CFR}_{Rj} = \sum_{i=1}^{m} p_{ij} \cdot j \tag{4}$$

where $i$ stands for the row index and $j$ represents the column index in the $M$ matrix.

The obtained weighted values should be then ranked to determine the crisp positional ranking. The lower the values, the better positions in the ranking should be assigned.

**Positional ranking with preference scores** The second approach to determine a compromise ranking with a CFR method relies on combining the preference scores obtained from the MCDA methods with the positional rankings established based on them. By integrating these two popular approaches for reaching consensus, CFR seeks to offer a more comprehensive and nuanced perspective as it includes more information to determine the final compromise solution. The calculation formula for this variant is expressed as (5):

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$$CFR_{R+P} = CFR_R \cdot \left( \frac{\sum_{i=1}^{m} dist}{N} + 1 \right) \tag{5}$$

where N is the number of rankings to be compromised, and m is the number of alternatives.

In this equation, *dist* represents the distance of preference value from the optimal ranking alternative. The study employed min-max normalization, where equation (6) was utilized for preference values when the alternative with the highest preference should be ranked first. Conversely, equation (7) was applied when the alternative with the lowest preference should be ranked first.

$$dist = \frac{\max(x) - x}{\max(x) - \min(x)} \tag{6}$$

$$dist = \frac{x - \min(x)}{\max(x) - \min(x)} \tag{7}$$

## 4 Study case

This section employs two methodologies to introduce the proposed compromise fuzzy ranking. Firstly, a simulation-based approach is utilized to elucidate the general characteristics of the proposed method. This analysis examines its performance concerning variations in the number of alternatives and criteria within decision-making scenarios and offers comparisons with established compromise methodologies. Secondly, a decision-problem-based approach is employed, involving the generation of random decision-making problems to underscore disparities between the proposed approach and existing compromise methodologies. The flowchart depicting the conducted studies is presented in Figure 1.

### 4.1 Simulation

A dataset of one thousand decision problems was generated in the simulation, with values randomly sampled from the interval $[0, 1]$. Each problem initially had equal weights assigned to all criteria for uniformity during the initial evaluation phase. Results from three multi-criteria decision analysis methods (TOPSIS [2], VIKOR [12], and MARCOS [21]) were used for compromise generation. These rankings and preferences were then employed in the CFR process to achieve consensus. A comparative study was conducted to assess the differences between CFR using rankings alone ($\mathrm{CFR}_R$) and CFR using both preferences and rankings ($\mathrm{CFR}_{R+P}$). The comparison focused on varying the number of alternatives while keeping the criteria fixed at five, as shown in Figure 2. The similarity between the two methods was evaluated using Spearman's weighted correlation coefficient. Results showed generally comparable outcomes, with slight discrepancies when the number of alternatives was low. However, with more alternatives, the two approaches were more congruent.

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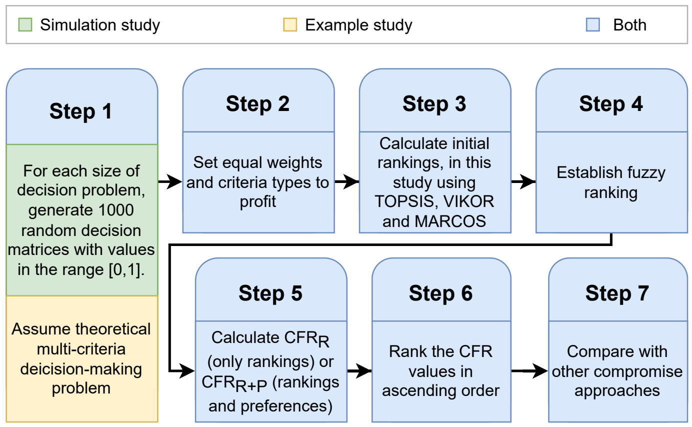


**Fig. 1.** Flowchart representing steps of the proposed study concerning simulation study and a theoretical example for validating the proposed Compromise Fuzzy Ranking approach.

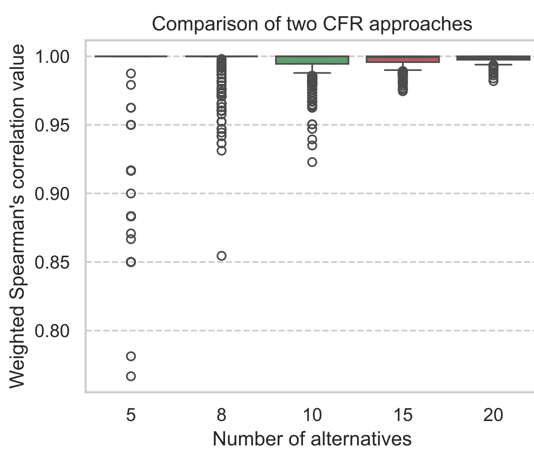


**Fig. 2.** Comparison of CFR rankings acquired using rankings and rankings with preferences for a different number of alternatives.

Next, the performance of both approaches was subsequently evaluated concerning the number of criteria present in the decision problem, maintaining a constant number of alternatives at ten. The outcomes across various sizes of the decision matrix are illustrated in Figure 3. Notably, significant disparities emerged when the decision problem featured eight criteria. Conversely, smaller discrepancies were observed with either a higher or lower number of criteria. Nevertheless, it is noteworthy that the distinctions between CFR$_R$ and CFR$_{R+P}$ were not substantial, with Spearman's weighted correlation coefficient consis-

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tently surpassing 0.9 in each scenario. This suggests that supplementary information, such as preference values obtained from experts or derived from multi-criteria decision-making methods, can slightly influence the final compromise ranking.

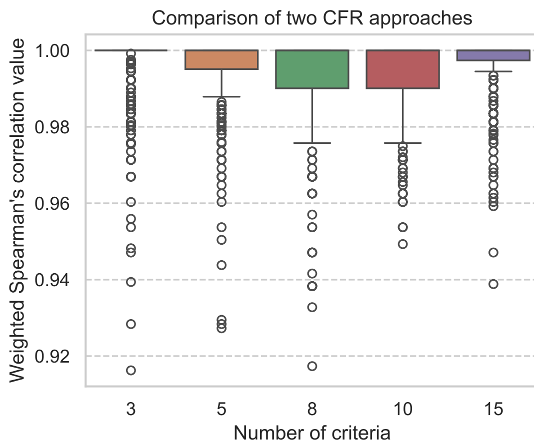


**Fig. 3.** Comparison of CFR rankings acquired using rankings and rankings with preferences for a different number of criteria.

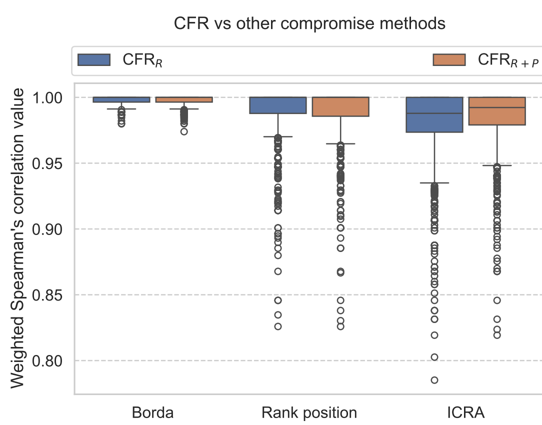


**Fig. 4.** Comparison of CFR rankings and other compromise approaches using Weighted Spearman's correlation coefficient.

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The final simulations aimed to compare the compromise fuzzy ranking with other methodologies for deriving compromise rankings. Specifically, CFR outcomes were compared with those obtained from a Borda voting method, a rank position method, and the ICRA method, which exclusively utilizes preference values. In these simulations, the decision problems featured five criteria and ten alternatives. A summarized depiction of the correlation between approaches is provided in Figure 4. Both CFR variants exhibited a relatively high degree of similarity with the Borda method, although discrepancies were evident. Subsequently, the rankings derived from the rank position method exhibited the closest resemblance, followed by ICRA. Notably, CFR utilizing both preference values and rankings exhibited higher similarity with ICRA outcomes, underscoring the impact of incorporating additional information regarding the discernible differences among the alternatives.

### 4.2 Example

This section examines a theoretical decision problem involving eight alternatives and five criteria. The decision matrix, shown in Table 1, outlines the values associated with each alternative. The selection of this theoretical problem was intentional to demonstrate potential discrepancies in compromise rankings across different methods. The five criteria were chosen to represent common decision factors in practical scenarios, with each criterion being profit-oriented. For simplicity and to avoid bias, all criteria were assigned equal weights of 0.2. The data for the alternatives were generated using a controlled process that simulated realistic decision-making situations, ensuring consistency across the alternatives while highlighting differences in rankings. This setup allows for the systematic evaluation of the impact of varying compromise methods on decision outcomes.

**Table 1.** Decision matrix used for calculations in the theoretical decision-making problem.

| $A_i$ | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ |
|---|---|---|---|---|---|
| $A_1$ | 0.3326 | 0.4680 | 0.6421 | 0.4462 | 0.6863 |
| $A_2$ | 0.8418 | 0.2332 | 0.1900 | 0.6967 | 0.9644 |
| $A_3$ | 0.0194 | 0.4451 | 0.3485 | 0.9786 | 0.5568 |
| $A_4$ | 0.1537 | 0.1806 | 0.8052 | 0.1186 | 0.3344 |
| $A_5$ | 0.4912 | 0.5349 | 0.3411 | 0.9884 | 0.4734 |
| $A_6$ | 0.8962 | 0.8918 | 0.7074 | 0.3993 | 0.4367 |
| $A_7$ | 0.1293 | 0.6296 | 0.5527 | 0.6724 | 0.9234 |
| $A_8$ | 0.3166 | 0.1253 | 0.5903 | 0.5984 | 0.8978 |

Subsequently, utilizing the aforementioned decision matrix, the preferences of distinct alternatives were computed employing three distinct multi-criteria decision-making methods: TOPSIS, VIKOR, and MARCOS. The resultant preference values were then ranked and are presented in Table 2. Notably, the rankings yielded by the TOPSIS and MARCOS methods are identical. However, it is

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acknowledged that in practical scenarios, instances may arise where two out of three experts agree with one another and only one expert presents a different assessment. Conversely, concerning the ranking produced by the VIKOR method, considerable disparities are observed, particularly in evaluating the alternative one, which is positioned in the first place by VIKOR but ranked fifth by TOPSIS and MARCOS. The Spearman's weighted correlation between VIKOR and the other rankings is 0.6, underscoring substantial alterations in the alternatives' rankings.

**Table 2.** Ranking of alternatives for the considered theoretical multi-criteria problem.

| $A_i$ | TOPSIS | VIKOR | MARCOS |
|---|---|---|---|
| $A_1$ | 5 | 1 | 5 |
| $A_2$ | 3 | 5 | 3 |
| $A_3$ | 7 | 7 | 7 |
| $A_4$ | 8 | 8 | 8 |
| $A_5$ | 4 | 3 | 4 |
| $A_6$ | 1 | 2 | 1 |
| $A_7$ | 2 | 4 | 2 |
| $A_8$ | 6 | 6 | 6 |

The aforementioned rankings were then used to construct a compromise assessment. Consistent with the simulation section, two variations of the Compromise Fuzzy Ranking (CFR) were utilized: one exclusively utilizing rankings and another incorporating preference values alongside rankings. First, to facilitate this process, it is imperative to compute a fuzzy ranking employing the procedures delineated in Section 3.1. Using the rankings derived from TOPSIS, VIKOR, and MARCOS, a fuzzy ranking was constructed, which is presented in Table 3. In this case, due to the discrepancies in the initially obtained rankings, the fuzzy ranking manifested with numerous values not equal to 1, signifying that alternatives could occupy multiple positions. Consequently, in such scenarios, a compromise is executed to obtain one final ranking.

**Table 3.** Fuzzy ranking calculated for the considered theoretical multi-criteria problem.

| Position | $A_1$ | $A_2$ | $A_3$ | $A_4$ | $A_5$ | $A_6$ | $A_7$ | $A_8$ |
|---|---|---|---|---|---|---|---|---|
| 1 | $\frac{1}{3}$ | 0 | 0 | 0 | 0 | $\frac{2}{3}$ | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | $\frac{1}{3}$ | $\frac{2}{3}$ | 0 |
| 3 | 0 | $\frac{2}{3}$ | 0 | 0 | $\frac{1}{3}$ | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | $\frac{2}{3}$ | 0 | $\frac{1}{3}$ | 0 |
| 5 | $\frac{2}{3}$ | $\frac{1}{3}$ | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 7 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |

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The $\mathrm{CFR}_R$ was then calculated using the Equation (4), which is based on ranking positions only, and the $\mathrm{CFR}_{R+P}$ using the Equation (5), which incorporates both ranking positions and preference values for individual alternatives. The resultant values for each alternative in this problem are detailed in Table 4. Notably, alternatives one, two, and five exhibited position swaps following the incorporation of preference values. This observation underscores the discerning effect of additional information in the form of preference values, leading to notable alterations in alternative rankings.

**Table 4.** Compromise Fuzzy Ranking (CFR) values for the considered problem.
* $\mathrm{CFR}_R$: ranking, $\mathrm{CFR}_{R+P}$: ranking with preference scores

| | $A_1$ | $A_2$ | $A_3$ | $A_4$ | $A_5$ | $A_6$ | $A_7$ | $A_8$ |
|---|---|---|---|---|---|---|---|---|
| $\mathrm{CFR}_R$ | 3.6668 | 3.6666 | 7.0000 | 8.0000 | 3.6667 | 1.3333 | 2.6666 | 6.0000 |
| $\mathrm{CFR}_{R+P}$ | 4.7646 | 5.0883 | 11.8563 | 16.0000 | 4.8506 | 1.3723 | 3.2974 | 9.2078 |

In addition to the CFR approaches, alternative methods for deriving compromise ranking were implemented, including Borda, rank position, and ICRA. The rankings yielded by each of these methods are depicted in Figure 5. Notably, unanimous consensus is observed among all compromise methods regarding the ranking of alternative six in the first position and alternatives eight, three, and four in the last three positions. Slight deviations are discernible with alternatives five and seven, as the rank position method positioned them differently, albeit with a minor shift of one position. Substantial discrepancies emerge sequentially for the second and first alternatives, with each compromise method assigning a distinct ranking position to the first alternative.

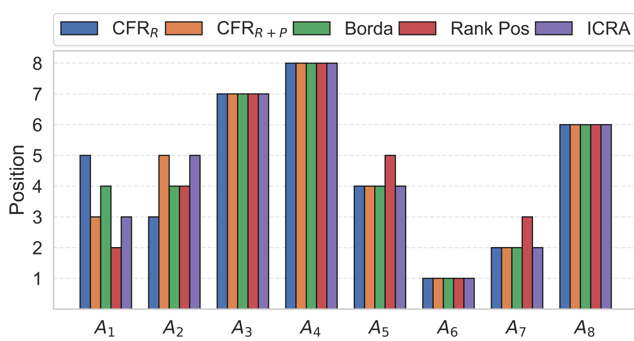


**Fig. 5.** Comparison of the obtained compromise rankings calculated with the selected methods.

Spearman's weighted correlation coefficient was used to accurately capture discrepancies among the obtained rankings, as shown in the correlation matrix in

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Figure 6. This allows for a direct comparison of the rankings produced by different compromise methods. A key observation is the difference between $\mathrm{CFR}_R$ and $\mathrm{CFR}_{R+P}$ rankings, despite both showing equal similarity to the Borda method. In contrast, greater discrepancies are observed when compared with the rank position and ICRA methods, with $\mathrm{CFR}_{R+P}$ showing higher similarity in both cases. Notably, the correlation between $\mathrm{CFR}_{R+P}$ and ICRA reaches 1, indicating identical rankings. This result contrasts with previous research, where methods typically based solely on positional rankings failed to achieve such alignment. The finding underscores the benefit of incorporating preference scores, which is information often omitted in earlier studies. Relying only on rank positions may overlook meaningful distinctions, which can significantly affect the final decision. Therefore, adaptable methods like CFR that leverage richer input data offer more realistic and reliable consensus rankings.

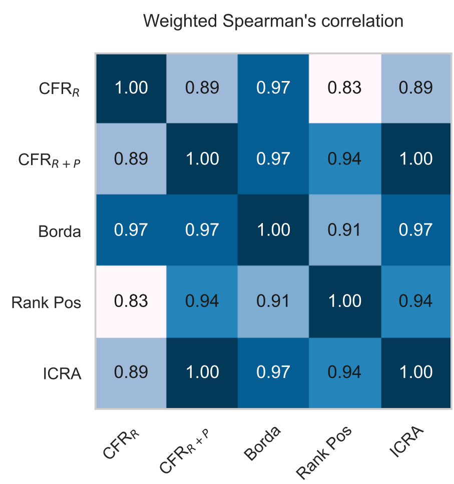


**Fig. 6.** Comparison of correlations between the obtained compromise rankings calculated with Weighted Spearman coefficient.

## 5 Discussion

The proposed Compromise Fuzzy Ranking method offers a novel way to aggregate conflicting rankings by combining positional rankings and preference scores, which is an aspect often overlooked in traditional approaches. Built on the concept of fuzzy ranking, CFR captures more nuanced knowledge across multiple evaluations, addressing key limitations in existing methods. Researchers can adapt this approach to integrate diverse data sources, enabling deeper insights and more reliable compromise solutions, ultimately enhancing the effectiveness of decision-making models in complex scenarios.

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The simulation phase was utilized to model theoretical decision problems, examining how the proposed method performs across varied scenarios with different problem characteristics. Three MCDA methods (TOPSIS, VIKOR, and MARCOS) were arbitrarily selected to represent cases where multiple evaluation methods are applied, reflecting common practices in contemporary research directed toward multi-criteria decision assessments. While small differences were noted between the two variants of CFR, the results remained coherent. Comparative studies with other compromise solution methods revealed similar consensus recommendations, yet the proposed method introduced additional insights by showcasing certain alterations in rankings. Thus, the simulations demonstrated that integrating positional rankings with preference scores in the consensus calculation process by the proposed CFR method could yield new findings for decision-makers across diverse decision problem specifications.

The decision-problem-based approach analyzed a theoretical scenario to highlight discrepancies in compromise rankings from different techniques. Rankings from MCDA methods were used to generate compromise assessments through two variants of CFR, Borda, Rank Position, and ICRA methods. Spearman's weighted correlation coefficient revealed differences among these rankings, with substantial changes in ranking order within the selected MCDA methods. This demonstrated the case's suitability for establishing consensus rankings. Additionally, compromise solution methods led to slightly divergent recommendations, especially for alternatives $A_1$ and $A_2$. The proposed CFR method, with its variants, produced a slightly different order of compromise rankings, emphasizing its potential to enhance the decision-making process and provide more informed decisions based on problem characteristics.

While CFR enhances decision support by integrating positional rankings and preference scores, it faces certain limitations. The combination of these components, often expressed in different scales, may require additional pre-processing for consistency. CFR's performance can also be sensitive to problem characteristics and data quality. In cases of high uncertainty or ambiguous criteria, generating reliable consensus rankings may be challenging. Despite these issues, CFR offers a valuable step toward more informed and robust multi-criteria decisions.

## 6 Conclusion

The Compromise Fuzzy Ranking (CFR) method presents a promising approach for enhancing decision support systems by providing more comprehensive and nuanced consensus rankings, particularly when faced with diverse evaluations from multiple MCDA methods. By integrating both positional rankings and preference scores, CFR offers decision-makers a more informed basis for decision-making. In contrast, existing compromise solutions often overlook the synergy between these two components, limiting their ability to provide accurate and reliable recommendations. In real-world applications, CFR can be particularly useful in complex decision scenarios such as project selection, resource allocation, and policy formulation, where multiple criteria and conflicting opinions must be

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reconciled. However, the method's effectiveness may be influenced by factors such as the quality of input data and the extent of uncertainty in the criteria.

Future work could explore CFR's performance with MCDA methods that yield preference scores on varying scales. Additionally, applying CFR to real-world complex decision problems and comparing it with existing techniques would help assess its practical value and potential to provide added insights for decision-makers.

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