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Integrated INN-MACONT Framework with Interval Neutrosophic MAGDM: Enhancing Services Performance Evaluation in Library and Information Institutions from the Perspective of User Experience

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Abstract: From the perspective of user experience, the performance evaluation of services in library and information institutions focuses on the ease of use, satisfaction, and responsiveness to user needs. By analyzing the experiences users gain during service utilization, key factors such as convenience, personalization, and efficiency are assessed. User feedback serves as a core basis for improving service quality, helping institutions optimize service processes, enhance user engagement, and continuously innovate to better meet diverse user needs and expectations, ultimately maximizing the value of the services provided. The services performance evaluation in library and information institutions from the perspective of user experience is multiple-attribute group decision-making (MAGDM). Recently, the MACONT approach was illustrated to put forward MAGDM. The interval neutrosophic sets (INSs) are illustrated as a tool for managing fuzzy data during the services performance evaluation in library and information institutions from the perspective of user experience. In this work, the interval neutrosophic number MACONT (INN-MACONT) approach is illustrated to put forward the MAGDM under INSs. Ultimately, a numerical analysis for services performance evaluation in library and information institutions from the perspective of user experience is illustrated to validate the proposed approach.

Keywords: multiple-attribute group decision-making; INSs; MACONT model; quality evaluation

1. Introduction

Evaluating the performance of services in library and information institutions from the perspective of user experience holds profound significance. First, it enables institutions to gain deep insights into users' real needs, feelings, and pain points during their service usage. By systematically collecting and analyzing user feedback, institutions can identify service shortcomings and take targeted improvement measures, thereby enhancing service quality. Second, user experience evaluation focuses on aspects such as service convenience, response speed, and personalized recommendations, which can effectively increase user satisfaction and retention. In today's era of information overload and digital transformation, with user expectations continually rising, library and information institutions must consistently optimize user experience to remain competitive and attract more users to their services. Moreover, performance evaluation based on user experience can drive service innovation and personalization. By thoroughly exploring user preferences and behavior, institutions can provide more tailored services that better meet users' needs, improving resource utilization efficiency. This user-centered evaluation approach also helps institutions better adapt to technological changes and evolving user demands, ensuring the sustainable development of services. Ultimately, performance evaluation from the perspective of user experience not only enhances the quality of services but also strengthens the institution's societal influence and resource utilization effectiveness. The services performance evaluation in library and information institutions from the perspective of user experience is MAGDM. Currently, the TODIM approach [1, 2] and MACONT approach [3] was illustrated for MAGDM. The advantages of the MACONT approach [3] lie in its ability to handle the complexity of multi-attribute decision-making problems, especially when there are multiple fuzzy and uncertain factors. This method ensures that the influence of each attribute is reasonably considered through the weighted evaluation of continuous attributes. MACONT approach [3] can also effectively manage the interdependencies between attributes, ensuring comprehensiveness and consistency in decision-making. Additionally, it provides a flexible framework that adapts to different decision-making environments, enhancing the scientific rigor and accuracy of decisions, making it suitable for a wide range of practical applications. Neutrosophic theory [4] is particularly well-suited for scenarios where data is unreliable, vague, or incomplete. In the context of services performance evaluation in library and information institutions from the user experience perspective, there are often uncertainties related to user feedback, service usage patterns, and satisfaction levels [5]. Neutrosophic theory, especially with the use of interval neutrosophic sets (INSs) [6], allows for a more flexible and comprehensive representation of these uncertainties compared to traditional fuzzy sets. This is crucial when evaluating subjective factors like user satisfaction, where responses may not always be categorical or definitive. Thus, the interval NSs (INSs) [6] are illustrated as a approach for managing uncertain data during the services performance evaluation in library and information institutions from the perspective of user experience. An integrated INN-MACONT approach is proposed to tackle MAGDM problems. To validate the effectiveness of this approach, a numerical example focused on the services performance evaluation in library and information institutions from the perspective of user experience is presented.

In summary, the motivation for this paper's research lies in addressing the limitations of current service performance evaluations in handling fuzzy data and multi-dimensional user experiences through the introduction of a more precise and innovative evaluation method, helping library and information institutions enhance service quality and user satisfaction. The research motivation of this paper can be analyzed from the following aspects:

(1)The importance of user experience in library and information institution services: With the development of information technology, the content and form of services in library and information institutions are constantly evolving. User experience has gradually become a critical standard for evaluating service quality. Enhancing user experience not only increases user satisfaction but also improves the efficiency of services and user engagement. Therefore, evaluating service performance from the perspective of user experience helps library and information institutions better understand user needs and make corresponding improvements and innovations.

(2)Limitations of existing evaluation methods: Traditional service performance evaluation methods may not fully consider the multi-dimensional factors of user experience, such as personalization, convenience, and responsiveness. Although existing MAGDM methods provide a certain analytical framework, they may have limitations in handling complex and fuzzy data. Thus, there is a need for more advanced and accurate tools to deal with these uncertainties.

(3)The need to handle fuzzy data: In the process of evaluating user experience, user feedback often exhibits fuzzy or uncertain characteristics, making it difficult to analyze with traditional precise data handling methods. To address this issue, this paper introduces interval neutrosophic sets (INSs), a tool that can better handle fuzzy and uncertain data, providing more accurate evaluation results.

(4) Introduction of an innovative evaluation method: To improve existing evaluation methods, this paper proposes the interval neutrosophic number MACONT (INN-MACONT) approach, which uses the MACONT methods to address MAGDM problems. It utilizes interval neutrosophic sets to handle fuzzy data. This approach provides a more comprehensive and accurate evaluation of service performance, particularly in the context of user experience.

(5)The need for practical application and validation: To verify the effectiveness of the proposed method, the paper applies and validates it through numerical analysis. This not only demonstrates the feasibility of the method in actual service performance evaluations but also provides library and information institutions with a valuable tool to optimize service quality and improve user experience.

The main research contributions are outlined: (1) The MACONT method are applied under INSs; (2) average is used to handle weight information within INSs; (3) The INN-MACONT approach is introduced to solve MAGDM problems under INSs; (4) A numerical example of services performance evaluation in library and information institutions from the perspective of user experience, along with a comparative analysis, is provided to verify the INN-MACONT approach.

The research framework is outlined as follows. Section 2 introduces the concept of INSs. Section 3 presents the INN-MACONT approach, incorporating average method within the INS framework. In Section 4, a numerical example of services performance evaluation in library and information institutions from the perspective of user experience, along with a comparative analysis, is provided. Finally, Section 5 summarizes the conclusions.

2. Literature review

The service performance evaluation of library and information institutions from the perspective of user experience is crucial for improving service quality and meeting user needs. User experience reflects how users interact with the services, including factors like ease of use, responsiveness, and the relevance of information provided. By focusing on user feedback and satisfaction, institutions can identify areas for improvement and adapt their services to be more user-centric. This approach not only enhances the efficiency and effectiveness of services but also fosters greater user engagement and loyalty. In an era of rapid digital transformation, users expect personalized, timely, and seamless interactions. Thus, performance evaluation through the lens of user experience enables institutions to innovate and stay relevant. It also ensures that resource allocation is optimized to support services that directly address user demands. Ultimately, this user-focused evaluation leads to improved service outcomes, higher satisfaction, and long-term institutional growth and sustainability. The reviewed literature spans from 2009 to 2024, covering various aspects of library and information institutions, including knowledge services, think tank development, and service innovation, with a focus on adapting to technological changes and user needs. In 2009, Wang, Wu and Zhang [7] conducted a study on the strategic management and influencing factors of knowledge services in library and information institutions. Their research combined strategic management theory with a three-dimensional framework of knowledge services, identifying key structural factors that influence the effectiveness of knowledge services in libraries. This study provided a foundation for the future development of service strategies in library institutions. In 2011, Yang [8] analyzed the characteristics of user needs in the network environment, noting that users required diverse, timely, accurate, and convenient information. The study proposed innovative service models, such as online databases and real-time consultation services, to better meet the evolving demands of users in a digital context. By 2012, Wu [9] had conducted a comprehensive study on user satisfaction in digital reference services. Using both asynchronous and real-time consultation models, Wu measured user expectations, perceived quality, and satisfaction levels. This empirical research highlighted the importance of perceived value in shaping user satisfaction and loyalty within digital library services. In 2014, Chu and Li [10] explored the implications of Innovation 2.0 for information service innovation within libraries. They emphasized the role of user participation in transforming traditional service models and argued that user engagement had become a key driver of service innovation in the digital age. Song [11], in 2015, proposed a new service concept by suggesting a shift from knowledge services to smart services within library institutions. The study introduced innovative paths for this transition, emphasizing the potential for smart services to support think tank construction and other advanced institutional roles. Zhai [12], in 2016, investigated the mechanisms for ensuring information service security under an innovation-driven strategy. The paper outlined how library and information institutions could better support innovation by developing robust service mechanisms to adapt to the strategic needs of the country's innovation-driven economy. In 2017, Wang [13] focused on the role of library and information institutions in supporting the construction of new-type think tanks. Wang proposed that these institutions could enhance their internal think tank structures and mechanisms, thereby contributing to the long-term effectiveness and sustainability of think tank services. Tian [14], in 2018, explored the new opportunities for library institutions to provide knowledge services in support of think tank construction. The study highlighted how the integration of knowledge services into think tank development represented a significant opportunity for libraries in modern governance. In 2019, Li [15] analyzed the service priorities of library and information institutions within the framework of a new think tank strategy. Li's research identified key areas of focus for libraries to better support think tank construction, providing practical recommendations for improving service delivery in this context. Zhao [16], in 2020, explored the impact of 5G technology on library and information institutions, particularly its influence on knowledge services. The study argued that 5G technology would infuse new energy into library services, enabling institutions to leverage faster connectivity for more efficient and innovative knowledge delivery. In 2021, Dai [17] discussed the mission of library and information institutions in supporting national think tank construction. The paper suggested that libraries should play a more proactive role by integrating interdisciplinary data and focusing on innovative services to meet the needs of think tanks. He [18], in 2022, focused on improving service models in library institutions within the context of digital transformation. The study emphasized the importance of incorporating information technology to enhance service quality and efficiency, advocating for continuous innovation in the digital era. Zhang [19], in 2023, examined the role of library and information institutions in supporting think tank construction, emphasizing the importance of resource development and service innovation. Zhang suggested that libraries should explore new paths for providing services to think tanks in line with China's modernization efforts. Finally, in 2024, Tian, Lei, Chen and Chen [20] analyzed the role of libraries in fostering high-value patents, using the Institute of Urban Environment at the Chinese Academy of Sciences as a case study. The paper proposed information service strategies for supporting high-value patent cultivation, highlighting the critical role libraries play in the transfer of research outcomes. Through literature review, it could be seen that traditional service performance evaluation methods may not fully consider the multi-dimensional factors of user experience, such as personalization, convenience, and responsiveness. Although existing MAGDM methods provide a certain analytical framework, they may have limitations in handling complex and fuzzy data. Thus, there is a need for more advanced and accurate tools to deal with these uncertainties.

3. Preliminaries

Wang et al. [21] illustrated the SVNSs

Definition 1 [21]. The SVNSs is illustrated:

$$QA=\left\{\left(x,T_A\left(x\right),I_A\left(x\right),F_A\left(x\right)\right)\middle|x\in\Phi\right\} \quad (1)$$

where the $T_A\left(x\right),I_A\left(x\right),F_A\left(x\right)$ conducts the truth-membership, indeterminacy-membership and falsity-membership, $T_A\left(x\right),I_A\left(x\right),F_A\left(x\right)\in\left[0,1\right]$ and satisfies $0\le T_A\left(x\right)+I_A\left(x\right)+F_A\left(x\right)\le 3$.

Wang et al.[6] illustrated the INSs.

Definition 2[6]. The INSs is illustrated:

$$QA=\left\{\left(\phi,T_A\left(\phi\right),I_A\left(\phi\right),F_A\left(\phi\right)\right)\middle|\phi\in\Theta\right\} \quad (2)$$

where the $T_A(\phi), I_A(\phi), F_A(\phi)$ conducts the truth-membership, indeterminacy-membership and falsity-membership, $T_A(\phi), I_A(\phi), F_A(\phi) \subseteq [0,1]$ and $0 \le \sup T_A(\phi) + \sup I_A(\phi) + \sup F_A(\phi) \le 3$.

The INN (interval neutrosophic number) is illustrated as $QA = ([TL_A, TR_A],[IL_A, IR_A],[FL_A, FR_A])$, and $0 \le TR_A + IR_A + FR_A \le 3$.

Definition 3 [22]. Let $QA = ([TL_A, TR_A],[IL_A, IR_A],[FL_A, FR_A])$ be INN, the score value (SV) is illustrated:

$$SV(QA) = \frac{(2 + TL_A - IL_A - FL_A) + (2 + TR_A - IR_A - FR_A)}{6}, \; SV(QA) \in [0,1]. \quad (3)$$

Definition 4[22]. Let $QA = ([TL_A, TR_A],[IL_A, IR_A],[FL_A, FR_A])$ be INN, the accuracy value (AV) is illustrated:

$$AV(QA) = \frac{2 + (TL_A + TR_A) - (FL_A + FR_A)}{4}, \; AV(QA) \in [0,1] \; . \quad (4)$$

Huang et al. [23] illustrated the order for INNs.

Definition 5[22]. Let $QA = ([TL_A, TR_A],[IL_A, IR_A],[FL_A, FR_A])$ and $QB = ([TL_B, TR_B],[IL_B, R_B],[FL_B, FR_B])$ be INNs, $SV(QA) = \frac{(2 + TL_A - IL_A - FL_A) + (2 + TR_A - IR_A - FR_A)}{6}$ and $SV(QB) = \frac{(2 + TL_B - IL_B - FL_B) + (2 + TR_B - IR_B - FR_B)}{6}$, and $AV(QA) = \frac{2 + (TL_A + TR_A) - (FL_A + FR_A)}{4}$ and $AV(QB) = \frac{(TL_B + TR_B) - (FL_B + FR_B)}{2}$, then if $SV(QA) < SV(QB)$, then $QA < QB$; if

$SV(QA)=SV(QB)$, then (1) if $AV(QA)=AV(QB)$, then $QA=QB$; (2) if $AV(QA)<AV(QB)$, then $QA<QB$.

Definition 6[24]. Let $QA=([TL_A,TR_A],[IL_A,IR_A],[FL_A,FR_A])$ and $QB=([TL_B,TR_B],[IL_B,R_B],[FL_B,FR_B])$ be INNs, the operations are illustrated:

$$\text{(1) } QA\oplus QB=\begin{pmatrix}(TL_A+TL_B-TL_ATL_B,TR_A+TR_B-TR_ATR_B),\\ [IL_AIL_B,IR_AIR_B],[FL_AFL_B,FR_AFR_B]\end{pmatrix};$$

$$\text{(2)} QA\otimes QB=\begin{pmatrix}[TL_ATL_B,TR_ATR_B],\\ [IL_A+IL_B-IL_AIL_B,IR_A+IR_B-IR_AIR_B],\\ [FL_A+FL_B-FL_AFL_B,FR_A+FR_B-FR_AFR_B]\end{pmatrix};$$

$$\text{(3) } \xi QA=\begin{pmatrix}\left[1-(1-TL_A)^{\xi},1-(1-TR_A)^{\xi}\right],\\ \left[(IL_A)^{\xi},(IR_A)^{\xi}\right],\left[(FL_A)^{\xi},(FR_A)^{\xi}\right]\end{pmatrix},\xi>0;$$

$$\text{(4) } (QA)^{\xi}=\begin{pmatrix}\left[(TL_A)^{\xi},(TR_A)^{\xi}\right],\left[(IL_A)^{\xi},(IR_A)^{\xi}\right],\\ \left[1-(1-FL_A)^{\xi},1-(1-FR_A)^{\xi}\right]\end{pmatrix},\xi>0.$$

Definition 7[25]**.** Let $QA=([TL_A,TR_A],[IL_A,IR_A],[FL_A,FR_A])$ and $QB=([TL_B,TR_B],[IL_B,R_B],[FL_B,FR_B])$, then the INN Hamming distance (INNHD) is illustrated:

$$INNHD(QA,QB)=\frac{1}{6}\begin{pmatrix}|TL_A-QTL_B|+|TR_A-TR_B|+|IL_A-IL_B|+\\ |IR_A-QIR_B|+|FL_A-FL_B|+|FR_A-FR_B|\end{pmatrix} \quad (5)$$

The INNWG approach [24] are illustrated:

Definition 9[24]. Let $QA_j=\left(\left[TL_j,TR_j\right],\left[IL_j,IR_j\right],\left[FL_j,FR_j\right]\right)$ be INNs, INNWG operator is illustrated:

$$\begin{aligned} &\text{INNWG}\left(QA_1, QA_2, \ldots, QA_n\right) \\ &= \left(QA_1\right)^{w_1} \otimes \left(QA_2\right)^{w_2}, \ldots \otimes \left(QA_n\right)^{w_n} = \underset{j=1}{\overset{n}{\otimes}} \left(QA_j\right)^{w_j} \\ &= \begin{pmatrix} \left[\prod_{j=1}^{n}\left(TL_{ij}\right)^{w_j}, \prod_{j=1}^{n}\left(TR_{ij}\right)^{w_j}\right], \\ \left[1-\prod_{j=1}^{n}\left(1-FL_{ij}\right)^{w_j}, 1-\prod_{j=1}^{n}\left(1-FR_{ij}\right)^{w_j}\right], \\ \left[1-\prod_{j=1}^{n}\left(1-TL_{ij}\right)^{w_j}, 1-\prod_{j=1}^{n}\left(1-TR_{ij}\right)^{w_j}\right] \end{pmatrix} \end{aligned} \tag{7}$$

where $w = \left(w_1, w_2, ..., w_n\right)^T$ be weight of QA_j, $w_j > 0, \sum_{j=1}^{n} w_j = 1.$

4. INN-MACONT approach

4.1. INN-MAGDM issues

The INN-MACONT approach is illustrated for MAGDM. Let $QA = \left\{QA_1, QA_2, \cdots, QA_m\right\}$ be alternatives and $QG = \left\{QG_1, QG_2, \cdots, QG_n\right\}$ be attributes with weight ω, where $\omega_j \in [0,1]$, $\sum_{j=1}^{n} \omega_j = 1$ and experts $QE = \left\{QE_1, QE_2, \cdots, QE_q\right\}$ with weight w, where $w_j \in [0,1]$, $\sum_{j=1}^{n} w_j = 1.$

Then, INN-MACONT approach is illustrated for MAGDM (See Figure 1):

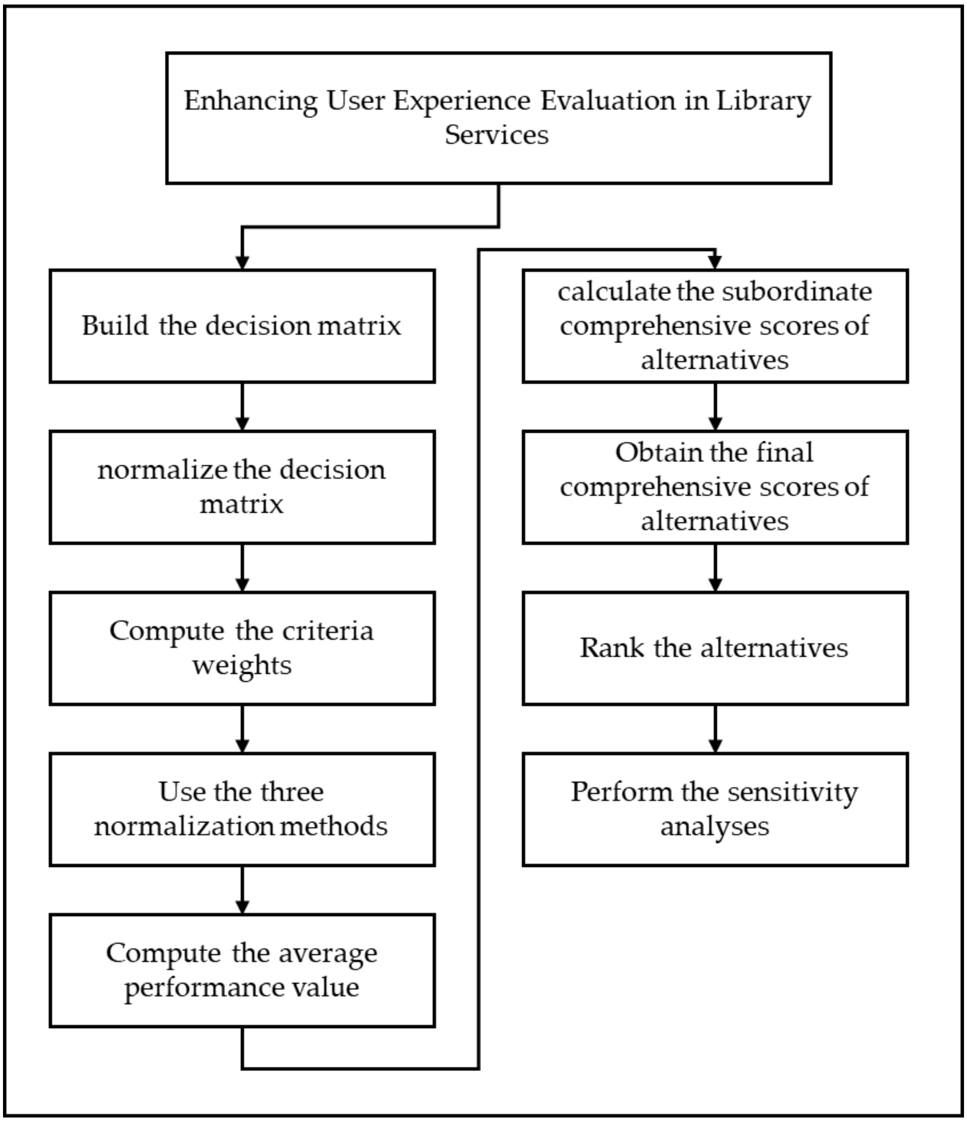

Figure 1. INN-MACONT approach for MAGDM

Step 1. Illustrate the group INN-matrix $RR^{(t)} = \left[RR_{ij}^{(t)}\right]_{m\times n} = \left(\left[TL_{ij}^{(t)}, TR_{ij}^{(t)}\right], \left[IL_{ij}^{(t)}, IR_{ij}^{(t)}\right], \left[FL_{ij}^{(t)}, FR_{ij}^{(t)}\right]\right)_{m\times n}$ and average INN-matrix $RR = \left[RR_{ij}\right]_{m\times n}$:

$$RR = \left[RR_{ij}^{(t)}\right]_{m\times n} = \begin{array}{c} \\ QA_1 \\ QA_2 \\ \vdots \\ QA_m \end{array} \begin{array}{c} \begin{array}{cccc} QG_1 & QG_2 & \cdots & QG_n \end{array} \\ \begin{bmatrix} RR_{11}^{(t)} & RR_{12}^{(t)} & \cdots & RR_{1n}^{(t)} \\ RR_{21}^{(t)} & RR_{22}^{(t)} & \cdots & RR_{2n}^{(t)} \\ \vdots & \vdots & \vdots & \vdots \\ RR_{m1}^{(t)} & RR_{m2}^{(t)} & \cdots & RR_{mn}^{(t)} \end{bmatrix} \end{array} \tag{8}$$

$$RR = \left[RR_{ij} \right]_{m\times n} = \begin{matrix} & QG_1 & QG_2 & \cdots & QG_n \\ QA_1 & RR_{11} & RR_{12} & \cdots & RR_{1n} \\ QA_2 & RR_{21} & RR_{22} & \cdots & RR_{2n} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ QA_m & RR_{m1} & RR_{m2} & \cdots & RR_{mn} \end{matrix} \tag{9}$$

In light with INNWG approach,

The $RR = \left[RR_{ij} \right]_{m\times n} = \left(\left[TL_{ij}, TR_{ij} \right], \left[IL_{ij}, IR_{ij} \right], \left[FL_{ij}, FR_{ij} \right] \right)_{m\times n}$ is illustrated:

$$RR_{ij} = \left(QR_{ij}^{(1)} \right)^{w_1} \otimes \left(QR_{ij}^{(2)} \right)^{w_2} \otimes \cdots \otimes \left(QR_{ij}^{(q)} \right)^{w_q}$$
$$= \left(\begin{array}{l} \left[\prod_{t=1}^{q} \left(TL_{ij}^{(t)} \right)^{w_j}, \prod_{t=1}^{q} \left(TR_{ij}^{(t)} \right)^{w_j} \right], \\ \left[1 - \prod_{t=1}^{q} \left(IL_{ij}^{(t)} \right)^{w_j}, 1 - \prod_{t=1}^{q} \left(IR_{ij}^{(t)} \right)^{w_j} \right], \\ \left[\prod_{t=1}^{q} \left(1 - FL_{ij}^{(t)} \right)^{w_j}, \prod_{t=1}^{q} \left(1 - FR_{ij}^{(t)} \right)^{w_j} \right] \end{array} \right) \tag{10}$$

Step 2. Illustrate the normalized the $NR = \left[NR_{ij} \right]_{m\times n}$ from the $RR = \left[RR_{ij} \right]_{m\times n}$.

Aimed at benefit attributes:

$$\begin{aligned} NR_{ij} &= \left(\left[TL_{ij}^{N}, TR_{ij}^{N} \right], \left[IL_{ij}^{N}, IR_{ij}^{N} \right], \left[FL_{ij}^{N}, FR_{ij}^{N} \right] \right) \\ &= RR_{ij} = \left(\left[TL_{ij}, TR_{ij} \right], \left[IL_{ij}, IR_{ij} \right], \left[FL_{ij}, FR_{ij} \right] \right) \end{aligned} \tag{11}$$

Aimed at cost attributes:

$$\begin{aligned} NR_{ij} &= \left(\left[TL_{ij}^{N}, TR_{ij}^{N} \right], \left[IL_{ij}^{N}, IR_{ij}^{N} \right], \left[FL_{ij}^{N}, FR_{ij}^{N} \right] \right) \\ &= \left(\left[FL_{ij}, FR_{ij} \right], \left[IL_{ij}, IR_{ij} \right], \left[TL_{ij}, TR_{ij} \right] \right) \end{aligned} \tag{12}$$

4.2. INN-MACONT method for MAGDM

The INN--MACONT is illustrated to put forward MAGDM.

Step 3. Illustrate relative weight:

$$r\omega_j = \omega_j \Big/ \max_j \omega_j, \tag{14}$$

Step 4. Illustrate the dominance degree numbers (DDN).

(1) The DDN of QA_i over QA_t under QG_j is illustrated:

$$DDN_j\left(QA_i,QA_t\right)=\begin{cases}\sqrt{\dfrac{r\omega_j\times\left(INNHD\left(NR_{ij},NR_{tj}\right)\right)}{\sum_{j=1}^{n}r\omega_j}} & \text{if } SV\left(NR_{ij}\right)>SV\left(NR_{tj}\right)\\ 0 & \text{if } SV\left(NR_{ij}\right)=SV\left(NR_{tj}\right)\\ -\dfrac{1}{\theta}\sqrt{\dfrac{\sum_{j=1}^{n}r\omega_j\times\left(INNHD\left(NR_{ij},NR_{tj}\right)\right)}{r\omega_j}} & \text{if } SV\left(NR_{ij}\right)<SV\left(NR_{tj}\right)\end{cases} \quad (15)$$

where θ is illustrated from agent's perception[26].

(2) The $DDN_j\left(QA_i\right)$ under QG_j is illustrated:

$$DDN_j\left(QA_i\right)=\left[DDN_j\left(QA_i,QA_t\right)\right]_{m\times m}$$

$$=\begin{matrix} & A_1 & QA_2 & \cdots & QA_m \\ \begin{matrix}QA_1\\QA_2\\\vdots\\QA_m\end{matrix} & \multicolumn{4}{l}{\begin{bmatrix} 0 & DDN_j\left(QA_1,QA_2\right) & \cdots & DDN_j\left(QA_1,QA_m\right)\\ DDN_j\left(QA_2,QA_1\right) & 0 & \cdots & DDN_j\left(QA_2,QA_m\right)\\ \vdots & \vdots & \cdots & \vdots\\ DDN_j\left(QA_m,QA_1\right) & DDN_j\left(QA_m,QA_2\right) & \cdots & 0\end{bmatrix}}\end{matrix}$$

(3) Illustrate the overall DDN of alternative QA_i for other ones for QG_j:

$$DDN_j\left(QA_i\right)=\sum_{t=1}^{m}DDN_j\left(QA_i,QA_t\right) \quad (16)$$

The overall DDN is illustrated:

$$DDN=\left(DDN_{ij}\right)_{m\times n}$$

$$=\begin{bmatrix} & QG_1 & QG_2 & \dots & QG_n\\ QA_1 & \sum_{t=1}^{m}DDN_1\left(QA_1,QA_t\right) & \sum_{t=1}^{m}DDN_2\left(QA_1,QA_t\right) & \dots & \sum_{t=1}^{m}DDN_n\left(QA_1,QA_t\right)\\ QA_2 & \sum_{t=1}^{m}DDN_1\left(QA_2,QA_t\right) & \sum_{t=1}^{m}DDN_2\left(QA_2,QA_t\right) & \dots & \sum_{t=1}^{m}DDN_n\left(QA_2,QA_t\right)\\ \vdots & \vdots & \vdots & \vdots & \vdots\\ QA_m & \sum_{t=1}^{m}DDN_1\left(QA_m,QA_t\right) & \sum_{t=1}^{m}DDN_2\left(QA_m,QA_t\right) & \dots & \sum_{t=1}^{m}DDN_n\left(QA_m,QA_t\right)\end{bmatrix} \quad (17)$$

Step 5. Standardize DDN based on three normalization approaches:

$$INNPDA_j=\max_{j=1}^{n}DDN_{ij},\ INNNDA_j=\min_{j=1}^{n}DDN_{ij} \quad (18)$$

$$NDDN_{ij}^{(1)}=\begin{cases}\dfrac{DDN_{ij}-INNNDA_j}{INNPDA_j-INNNDA_j}, & for\ benefit\ attribute\\ \dfrac{DDN_{ij}-INNPDA_j}{INNNDA_j-INNPDA_j}, & for\ \cos t\ attribute\end{cases} \tag{19}$$

$$NDDN_{ij}^{(2)}=\begin{cases}\dfrac{e^{DDN_{ij}}}{\sum_{i=1}^{m}e^{DDN_{ij}}{}_{ij}}, & for\ benefit\ attribute\\ \dfrac{1/e^{DDN_{ij}}}{\sum_{i=1}^{m}\left(1/e^{DDN_{ij}}\right)}, & for\ benefit\ attribute\end{cases} \tag{20}$$

$$NDDN_{ij}^{(3)}=\begin{cases}\dfrac{e^{DDN_{ij}}}{\max_i\left(e^{DDN_{ij}}\right)}, & for\ benefit\ attribute\\ \dfrac{\min_i\left(e^{DDN_{ij}}\right)}{e^{DDN_{ij}}}, & for\ \cos t\ attribute\end{cases} \tag{21}$$

Step 6. Illustrate three normalization approaches:

$$NDDN_{ij}=\lambda NDDN_{ij}^{(1)}+\mu NDDN_{ij}^{(2)}+\left(1-\lambda-\mu\right)NDDN_{ij}^{(3)} \tag{22}$$

where $0\leqslant\lambda,\mu\leqslant1$.

Step 7. Illustrate the comprehensive value (CV):

$$SV_i^{(1)}=\delta\frac{SQ_i^{(1)}}{\sqrt{\sum_{i=1}^{m}\left(SQ_i^{(1)}\right)^2}}+\left(1-\delta\right)\frac{SQ_i^{(2)}}{\sqrt{\sum_{i=1}^{m}\left(SQ_i^{(2)}\right)^2}} \tag{23}$$

where, $SQ_i^{(1)}=\sum_{j=1}^{n}\omega_j\left(NDDN_{ij}-\frac{1}{m}\sum_{i=1}^{m}NDDN_{ij}\right)$,

$$SQ_i^{(2)}=\frac{\prod_{x\times\gamma=1}^{n}\left(\frac{1}{m}\sum_{i=1}^{m}NDDN_{ij}-NDDN_{ij}\right)^{\omega_j}}{\prod_{x\times\eta=1}^{n}\left(NDDN_{ij}-\frac{1}{m}\sum_{i=1}^{m}NDDN_{ij}\right)^{\omega_j}},$$

$$CV_i^{(2)}=\begin{pmatrix}\theta\max_j\left(\omega_j\left(NDDN_{ij}-\frac{1}{m}\sum_{i=1}^{m}NDDN_{ij}\right)\right)\\ +\left(1-\theta\right)\min_j\left(\omega_j\left(NDDN_{ij}-\frac{1}{m}\sum_{i=1}^{m}NDDN_{ij}\right)\right)\end{pmatrix} \tag{24}$$

where $x \times \gamma\left(x \times \gamma = 1, 2, \cdots, n\right)$ is the attributes that meet $\frac{1}{m}\sum_{i=1}^{m} NDDN_{ij} \geq NDDN_{ij}$, and $x \times \gamma\left(x \times \gamma = 1, 2, \cdots, n\right)$ is the attributes that meet $NDDN_{ij} \geq \frac{1}{m}\sum_{i=1}^{m} NDDN_{ij}$. δ and $\theta\left(0 \leq \delta, \theta \leq 1\right)$ are parameters.

Step 8. Illustrate the overall comprehensive value (OCV):

$$OCV_i = \frac{1}{2}\left(CV_i^{(1)} + \frac{CV_i^{(2)}}{\sqrt{\sum_{i=1}^{m}\left(CV_i^{(2)}\right)^2}} \right), i = 1, 2, \cdots, m. \tag{25}$$

Step 9. In light with OCV, the largest OCV is the optimal choice.

5. Numerical example

From the perspective of user experience, the performance evaluation of services in library and information institutions focuses primarily on the overall user satisfaction and experience during service use. With the rapid development of information technology, users' expectations of services continue to rise. They not only demand speed and accuracy in information retrieval but also expect personalization, ease of use, and high efficiency in the services provided. Therefore, performance evaluation based on user experience has gradually become an important method for assessing the quality of services in library and information institutions. In this evaluation framework, it is essential to first understand the needs and expectations of users. By collecting user feedback, institutions can identify pain points and satisfaction levels during service use, thereby pinpointing areas that need improvement. Key evaluation indicators include service convenience, response speed, accuracy of information retrieval, and personalized resource recommendations. Additionally, the emotional experience of users when interacting with the service is crucial, such as whether they feel comfortable and whether it is easy to find the information they need. By monitoring these indicators, library and information institutions can optimize their service processes and improve user experience. To ensure objectivity and comprehensiveness, user experience evaluations typically combine both quantitative and qualitative analysis methods. For example, quantitative methods can analyze user satisfaction and service usage frequency through surveys and usage data, while qualitative methods such as interviews or focus groups can provide deeper insights into users' specific needs and suggestions for improvement. In summary, performance evaluation from the perspective of user experience helps library and information institutions better understand user needs, improve service quality, and continuously optimize and innovate. This enhances user engagement and satisfaction, allowing institutions to remain competitive in an increasingly challenging environment and achieve higher user retention. The services performance evaluation in library and information institutions from the perspective of user experience is a MAGDM. Six library and information institutions are chosen in light with 31 attributes [14]. Table 1 shows the list of criteria.

Table 1. The weights of criteria.

	Criteria	Weights
C_1	Satisfaction Metrics	0.028446
C_2	Adaptability to User Needs	0.028325
C_3	Diversity of Materials	0.032154
C_4	Physical Accessibility	0.035983
C_5	Resource Availability	0.035862
C_6	Customizability	0.034342
C_7	Workshops and Events	0.032823
C_8	Loyalty and Retention	0.028811
C_9	Integration with External Platforms	0.027292
C_{10}	Relevance and Currency	0.032397
C_{11}	Virtual Library Features	0.033066
C_{12}	Operating Hours	0.035254
C_{13}	Interlibrary Loan and Resource Sharing	0.034342
C_{14}	Feedback Mechanisms	0.032519
C_{15}	Mobile Accessibility	0.033552
C_{16}	Cost Effectiveness	0.026562
C_{17}	Content Quality	0.031425
C_{18}	Digital Catalog Usability	0.033917
C_{19}	Digital Accessibility	0.035923
C_{20}	Study and Collaboration Spaces	0.032884
C_{21}	Social Media and Communication	0.032519
C_{22}	Physical Environment	0.032944

C_{23}	Adoption of Emerging Trends	0.028325
C_{24}	Ease of Discovery	0.031911
C_{25}	Perceived Value	0.031242
C_{26}	Staff Responsiveness	0.035072
C_{27}	Noise Levels	0.032884
C_{28}	Outreach Programs	0.032519
C_{29}	Automated Systems	0.033187
C_{30}	Problem Resolution	0.029054
C_{31}	Efficiency of Services	0.034464

We built the decision matrix between the criteria and alternatives as shown in Table 2.

Then we compute the criteria weights as shown in Table 1.

Then we compute the three-normalization matrix as shown in Table 3.

Then we compute the calculate the subordinate comprehensive scores of alternatives.

Then we compute the Obtain the final comprehensive scores of alternatives.

Then we ranked the alternatives as shown in Figure 2.

Table 2. The decision matrix.

	A_1	A_2	A_3	A_4	A_5	A_6
C_1	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.15,0.3],[0.5,0.6],[0.65,0.8])
C_2	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.05,0.2],[0.6,0.7],[0.75,0.9])
C_3	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.75,0.9],[0.6,0.7],[0.05,0.20])
C_4	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.65,0.8],[0.5,0.6],[0.15,0.3])
C_5	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.45,0.6],[0.3,0.4],[0.25,0.5])
C_6	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.4,0.6],[0.1,0.20],[0.4,0.6])
C_7	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.25,0.4],[0.4,0.5],[0.55,0.7])
C_8	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.15,0.3],[0.5,0.6],[0.65,0.8])
C_9	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.05,0.2],[0.6,0.7],[0.75,0.9])
C_{10}	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.75,0.9],[0.6,0.7],[0.05,0.20])
C_{11}	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.65,0.8],[0.5,0.6],[0.15,0.3])
C_{12}	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.45,0.6],[0.3,0.4],[0.25,0.5])
C_{13}	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.4,0.6],[0.1,0.20],[0.4,0.6])
C_{14}	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.25,0.4],[0.4,0.5],[0.55,0.7])
C_{15}	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.15,0.3],[0.5,0.6],[0.65,0.8])
C_{16}	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.05,0.2],[0.6,0.7],[0.75,0.9])
C_{17}	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.75,0.9],[0.6,0.7],[0.05,0.20])
C_{18}	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.65,0.8],[0.5,0.6],[0.15,0.3])

C_{19}	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.45,0.6],[0.3,0.4],[0.25,0.5])
C_{20}	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.4,0.6],[0.1,0.20],[0.4,0.6])
C_{21}	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.25,0.4],[0.4,0.5],[0.55,0.7])
C_{22}	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.15,0.3],[0.5,0.6],[0.65,0.8])
C_{23}	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.05,0.2],[0.6,0.7],[0.75,0.9])
C_{24}	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.75,0.9],[0.6,0.7],[0.05,0.20])
C_{25}	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.65,0.8],[0.5,0.6],[0.15,0.3])
C_{26}	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.45,0.6],[0.3,0.4],[0.25,0.5])
C_{27}	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.4,0.6],[0.1,0.20],[0.4,0.6])
C_{28}	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.25,0.4],[0.4,0.5],[0.55,0.7])
C_{29}	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.15,0.3],[0.5,0.6],[0.65,0.8])
C_{30}	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])
C_{31}	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.75,0.9],[0.6,0.7],[0.05,0.20])
	A_1	A_2	A_3	A_4	A_5	A_6
C_1	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.15,0.3],[0.5,0.6],[0.65,0.8])
C_2	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])
C_3	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.75,0.9],[0.6,0.7],[0.05,0.20])
C_4	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.65,0.8],[0.5,0.6],[0.15,0.3])
C_5	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.45,0.6],[0.3,0.4],[0.25,0.5])
C_6	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.4,0.6],[0.1,0.20],[0.4,0.6])
C_7	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.25,0.4],[0.4,0.5],[0.55,0.7])
C_8	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.15,0.3],[0.5,0.6],[0.65,0.8])
C_9	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.05,0.2],[0.6,0.7],[0.75,0.9])
C_{10}	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.75,0.9],[0.6,0.7],[0.05,0.20])
C_{11}	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.65,0.8],[0.5,0.6],[0.15,0.3])
C_{12}	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.45,0.6],[0.3,0.4],[0.25,0.5])
C_{13}	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.4,0.6],[0.1,0.20],[0.4,0.6])
C_{14}	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.25,0.4],[0.4,0.5],[0.55,0.7])
C_{15}	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])
C_{16}	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.05,0.2],[0.6,0.7],[0.75,0.9])
C_{17}	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.75,0.9],[0.6,0.7],[0.05,0.20])
C_{18}	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.65,0.8],[0.5,0.6],[0.15,0.3])
C_{19}	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.45,0.6],[0.3,0.4],[0.25,0.5])
C_{20}	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.4,0.6],[0.1,0.20],[0.4,0.6])
C_{21}	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.25,0.4],[0.4,0.5],[0.55,0.7])
C_{22}	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.15,0.3],[0.5,0.6],[0.65,0.8])
C_{23}	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.05,0.2],[0.6,0.7],[0.75,0.9])
C_{24}	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])
C_{25}	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.65,0.8],[0.5,0.6],[0.15,0.3])
C_{26}	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.45,0.6],[0.3,0.4],[0.25,0.5])

C_{27}	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])
C_{28}	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.25,0.4],[0.4,0.5],[0.55,0.7])
C_{29}	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.15,0.3],[0.5,0.6],[0.65,0.8])
C_{30}	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.4,0.6],[0.1,0.20],[0.4,0.6])
C_{31}	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.75,0.9],[0.6,0.7],[0.05,0.20])
	A_1	A_2	A_3	A_4	A_5	A_6
C_1	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.15,0.3],[0.5,0.6],[0.65,0.8])
C_2	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.05,0.2],[0.6,0.7],[0.75,0.9])
C_3	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.75,0.9],[0.6,0.7],[0.05,0.20])
C_4	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.65,0.8],[0.5,0.6],[0.15,0.3])
C_5	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.45,0.6],[0.3,0.4],[0.25,0.5])
C_6	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.4,0.6],[0.1,0.20],[0.4,0.6])
C_7	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])
C_8	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.15,0.3],[0.5,0.6],[0.65,0.8])
C_9	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.05,0.2],[0.6,0.7],[0.75,0.9])
C_{10}	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])
C_{11}	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.65,0.8],[0.5,0.6],[0.15,0.3])
C_{12}	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.45,0.6],[0.3,0.4],[0.25,0.5])
C_{13}	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.4,0.6],[0.1,0.20],[0.4,0.6])
C_{14}	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.25,0.4],[0.4,0.5],[0.55,0.7])
C_{15}	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.15,0.3],[0.5,0.6],[0.65,0.8])
C_{16}	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.05,0.2],[0.6,0.7],[0.75,0.9])
C_{17}	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.75,0.9],[0.6,0.7],[0.05,0.20])
C_{18}	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])
C_{19}	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.45,0.6],[0.3,0.4],[0.25,0.5])
C_{20}	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])
C_{21}	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.25,0.4],[0.4,0.5],[0.55,0.7])
C_{22}	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.4,0.6],[0.1,0.20],[0.4,0.6])	([0.15,0.3],[0.5,0.6],[0.65,0.8])
C_{23}	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.05,0.2],[0.6,0.7],[0.75,0.9])
C_{24}	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])
C_{25}	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])
C_{26}	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.45,0.6],[0.3,0.4],[0.25,0.5])
C_{27}	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.4,0.6],[0.1,0.20],[0.4,0.6])
C_{28}	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.25,0.4],[0.4,0.5],[0.55,0.7])
C_{29}	([0.75,0.9],[0.6,0.7],[0.05,0.20])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.15,0.3],[0.5,0.6],[0.65,0.8])
C_{30}	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])
C_{31}	([0.15,0.3],[0.5,0.6],[0.65,0.8])	([0.25,0.4],[0.4,0.5],[0.55,0.7])	([0.65,0.8],[0.5,0.6],[0.15,0.3])	([0.05,0.2],[0.6,0.7],[0.75,0.9])	([0.45,0.6],[0.3,0.4],[0.25,0.5])	([0.75,0.9],[0.6,0.7],[0.05,0.20])

Table 3. The total normalized decision matrix.

	A_1	A_2	A_3	A_4	A_5	A_6
C_1	0.286305	1.279077	0.557061	1.211388	1.617521	0.421683
C_2	0.351975	1.574585	0.96328	0.90215	1.60515	0.504801
C_3	0.7091	1.12488	0.255521	1.35167	0.690201	1.616257
C_4	1.380609	0.435038	1.1624	0.580511	0.435038	1.598818
C_5	0.458217	0.378262	0.698082	1.337721	1.604237	1.204463
C_6	1.60354	0.324983	1.201031	0.324983	1.461478	1.461478
C_7	1.593519	0.440732	1.504843	1.283153	0.884111	0.928449
C_8	0.285616	1.277792	0.556209	1.34544	1.616034	0.420912
C_9	0.684903	1.387686	1.605791	1.387686	1.387686	0.248693
C_{10}	0.606335	1.120193	0.326049	1.470551	0.442835	1.610694
C_{11}	0.959064	1.391379	1.139195	1.499458	0.202512	1.607537
C_{12}	1.481694	0.30135	1.365974	1.088246	1.597414	1.481694
C_{13}	1.60354	0.324983	1.201031	0.324983	1.461478	1.461478
C_{14}	0.775988	0.919457	0.847723	0.991192	1.600935	0.417316
C_{15}	1.611413	1.092113	0.745913	0.313163	1.330125	0.551175
C_{16}	0.459185	1.309472	0.577829	1.625858	1.151279	0.221895
C_{17}	0.286833	0.932711	0.932711	0.851976	0.629955	1.618956
C_{18}	0.638574	1.265481	1.024363	1.603047	0.325121	1.578935
C_{19}	0.484753	0.378152	0.697954	1.337559	1.604061	1.204308
C_{20}	1.552988	0.311771	1.090574	1.090574	1.066237	1.601664
C_{21}	1.182781	0.564006	1.604673	0.367123	1.492168	0.564006
C_{22}	1.528468	1.236438	0.74972	1.309445	1.601476	0.311674
C_{23}	0.57977	1.43744	0.938795	1.616953	1.158199	0.220745
C_{24}	0.329231	1.611429	0.329231	1.207774	0.471697	1.516451
C_{25}	0.644327	0.886212	0.354065	1.611868	0.329877	1.587679
C_{26}	0.740684	0.321542	1.578967	0.950255	1.602253	1.369396
C_{27}	1.516384	0.536197	1.276783	0.274814	1.603512	1.559948
C_{28}	1.426055	0.726535	0.411751	1.041319	1.600935	0.446727
C_{29}	1.612637	0.76708	1.169727	0.646287	1.330785	0.283905
C_{30}	0.251617	1.216517	0.629186	1.300421	0.859923	1.615063
C_{31}	0.281972	0.643743	1.407482	0.844727	1.42758	1.608466

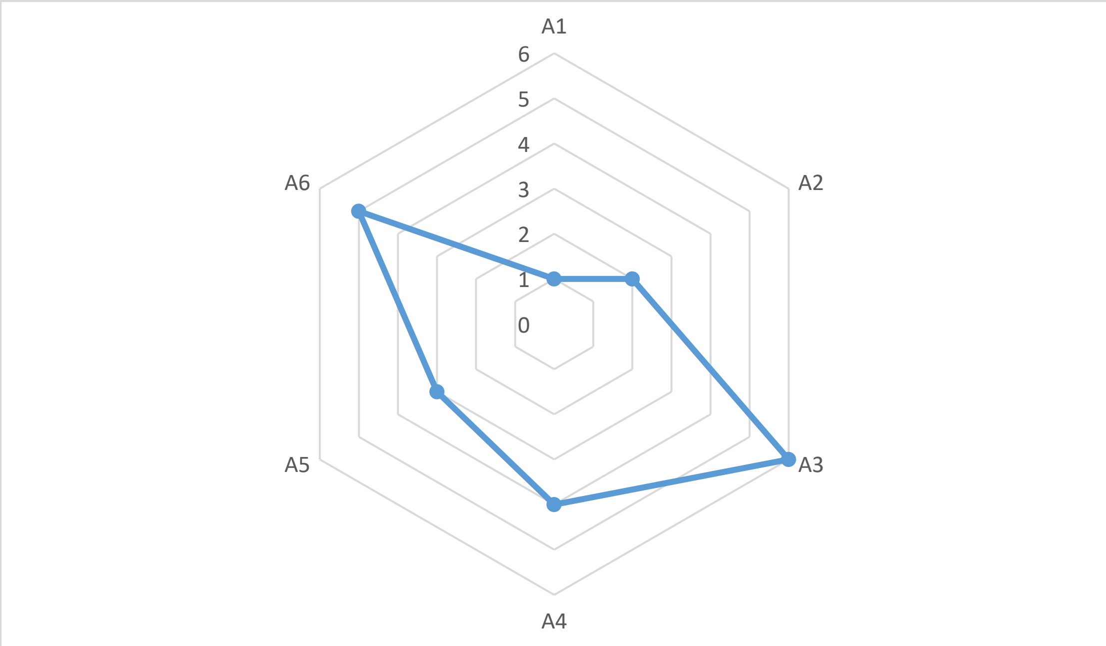

Figure 2. The rank of alternatives.

Sensitivity analysis

We change the criteria weights by 17 cases as shown in Figure 3. We change the criteria weights to rank the alternatives under different weights. Figure 4 shows the rank of alternatives. We applied the proposed model under different weights to show different results. The results show the proposed model is stable.

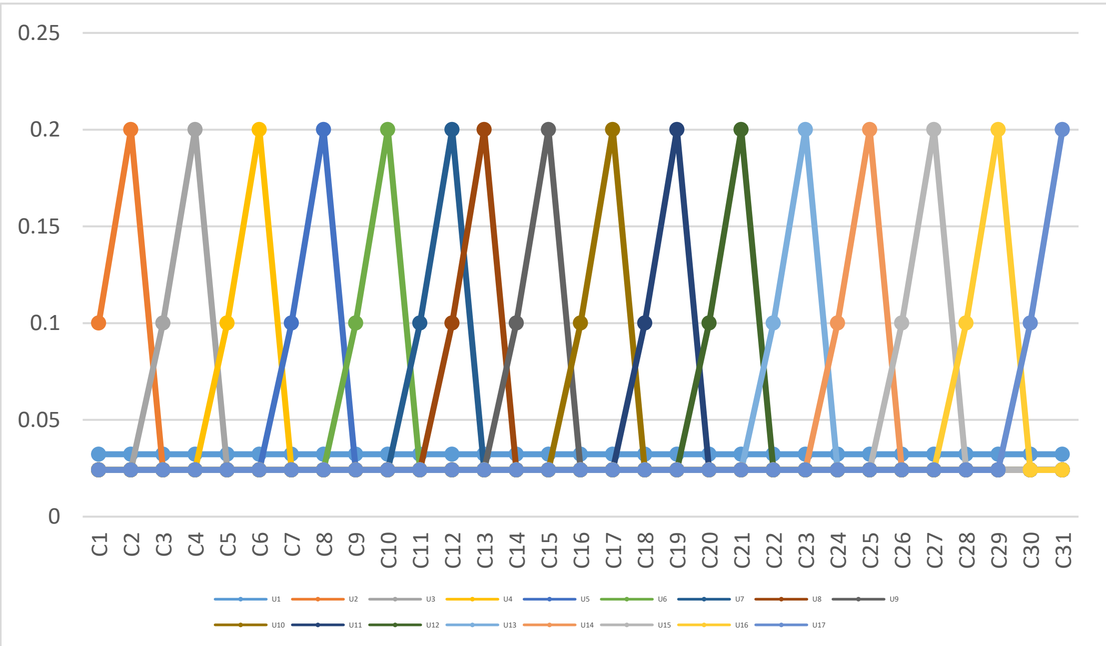

Figure 3. The criteria weights.

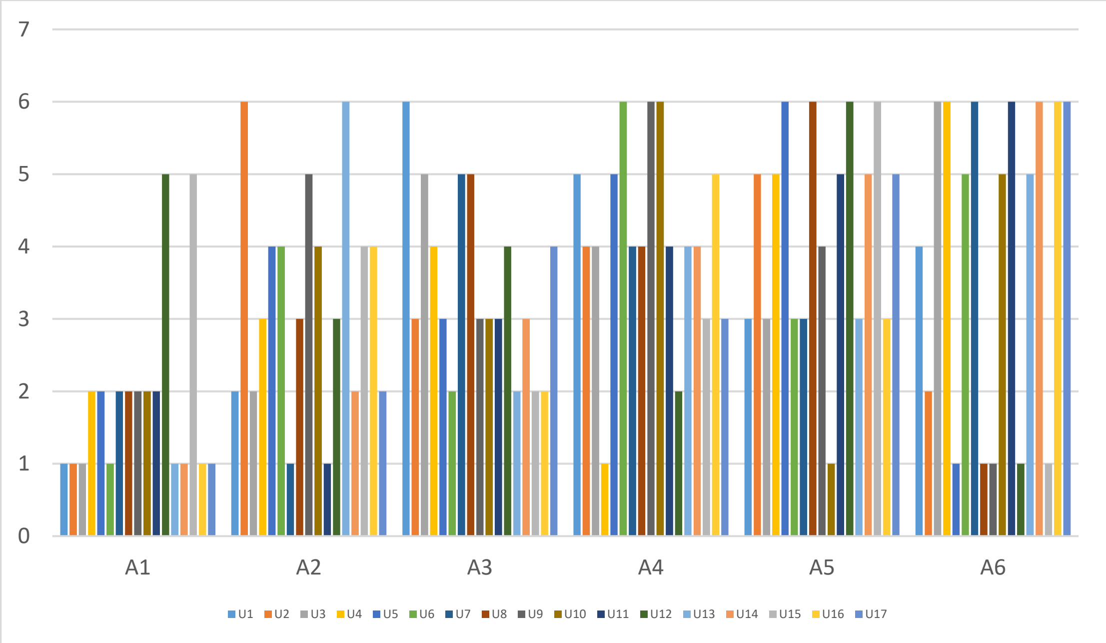

Figure 4. The different rank of alternatives.

6. Conclusion

From the perspective of user experience, the performance evaluation of services in library and information institutions focuses on the overall user satisfaction and experience during service use. Key evaluation factors include convenience, ease of use, the degree of personalization, the efficiency of information access, and the responsiveness to user needs. By collecting and analyzing user feedback, institutions can gain deeper insights into pain points and user needs during service interactions, allowing them to optimize service processes accordingly. User experience encompasses not only the design and functionality of the service interface but also the emotional experience users have when accessing information and utilizing resources. Additionally, user engagement and loyalty are important indicators of service performance. By enhancing the user experience, library and information institutions can increase user satisfaction and retention, achieve continuous service improvement and innovation, and ultimately boost the overall quality and value of their services. This user-centered evaluation approach helps institutions remain competitive in a challenging environment and better meet the diverse needs of their users. The performance evaluation of services in library and information institutions from the perspective of user experience is a MAGDM problem. Recently, the MACONT method have been applied to develop a new MAGDM approach. INSs are used to handle fuzzy information during the performance evaluation process. In this study, the INN-MACONT integration is utilized to enhance MAGDM under the INS framework. A numerical analysis is conducted to validate the effectiveness of the INN-MACONT approach in quality evaluation. The main contributions of this work are as follows: (1) Implementation of MACONT under INSs to advance MAGDM; (2) Use of average method to manage weight information within INSs; (3) Application of the INN-MACONT method to execute MAGDM under INSs; (4) A numerical example and comparative analysis are provided to demonstrate the efficacy of the INN-MACONT approach in service performance evaluation within library and information institutions from the perspective of user experience.

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