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University English Writing Teaching Quality Evaluation Driven by Artificial Intelligence in the Context of New Liberal Arts: Linguistic Neutrosophic Multivalued Approach

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Abstract:

In the evolving landscape of higher education, English writing instruction is being reshaped by the fusion of Artificial Intelligence (AI) and the New Liberal Arts framework. This study aims to develop a comprehensive quality evaluation model for university-level English writing education by integrating AI-driven insights with pedagogical innovation. This study uses decision making approaches to select the best criterion and alternative. We use the RAM method to rank the alternatives. The decision-making approach is used under the Linguistic Neutrosophic Multivalued to deal with uncertainty and vague information. Eight distinct criteria are established to assess instructional efficacy, linguistic competence development, cognitive engagement, and adaptive feedback mechanisms. Furthermore, eight alternatives, ranging from intelligent tutoring systems to generative text platforms, are evaluated. The framework not only enhances the objectivity of quality assessment but also promotes personalized and dynamic learning environments aligned with educational goals. The research offers actionable guidance for educators, administrators, and policymakers seeking to modernize writing instruction under the paradigm of AI and humanistic learning.

Keywords: Linguistic Neutrosophic Multivalued; Artificial Intelligence; Liberal Arts; English Writing Teaching.

1. Introduction

The convergence of Artificial Intelligence and the New Liberal Arts is revolutionizing English writing instruction in universities. While traditional methods focused heavily on static grammar instruction and essay correction, emerging digital ecosystems call for a more dynamic, personalized, and feedback-rich approach[1], [2]. In this context, AI technologies such as Natural Language Processing (NLP), intelligent writing assistants, and real-time assessment engines are increasingly employed to facilitate skill development, provide immediate feedback, and monitor learning progression. These technologies address long-standing gaps in teacher bandwidth and learner engagement. The New Liberal Arts movement emphasizes interdisciplinary thinking, creativity, and human-centered education. English writing, a key component of communication and critical thinking, plays a central role in cultivating these competencies. However, aligning writing pedagogy with this broader educational ethos remains a challenge[3], [4].

This study aims to build a robust framework for evaluating the quality of English writing instruction under this new paradigm. The framework incorporates AI capabilities as evaluative and pedagogical tools, allowing educators to gauge not only output but also learning processes and trajectories.

To realize this goal, we identify eight key criteria that span technological integration, cognitive activation, feedback responsiveness, and creativity enhancement. These criteria enable a nuanced, multi-layered analysis of instructional effectiveness and learner growth[5], [6].

Eight educational alternatives—ranging from AI-powered peer review systems to multimodal composition platforms—are considered within this model. Each alternative reflects different ways AI can enhance writing instruction and engagement, offering a spectrum of practical implementations[7], [8].

By combining data-driven evaluation with humanistic educational aims, this approach contributes to the next generation of writing instruction. It offers universities a pathway to align their curriculum with global academic trends, digital fluency requirements, and liberal arts competencies[9], [10].

A collection of data that is unknown up to a specific point is referred to as "neutrosophic data," and statistical techniques that are neutrosophic are used to analyze this type of data. The sample size in neutrosophic statistics might not be precisely the quantity that Smarandache provided[11], [12]. According to earlier studies, neutrosophic statistics are useful and ought to be included in the current uncertainty model. To investigate the gauge effect and anisotropy of the combined roughness coefficient, rock engineers have resorted to neutrosophic numbers. Consequently, sufficient fitting functions are produced, and the information loss is reduced[13], [14].

Neutrosophic logic, on the other hand, is an extension of fuzzy logic that allows one to assess inconclusive together with a definite percentage of the observations and may be used for analysis carried out in situations that are unclear or imprecise. In the domain of decision-making, fuzzy logic is undergoing a phase of fast methodological development and broad use. The next step up from fuzzy sets is represented by complex fuzzy sets, and its expanded version is known as a complex neutrosophic set given[15], [16]

The work of Li et al. contains a detailed flowchart of fuzzy sets and its extensions, including an analysis of interval-valued neutrosophic sets and a discussion of several attributes and operations. When it comes to decision-making, the neutrosophic set is a better option than the fuzzy set whenever the fuzzy set cannot deal with ambiguity. There are several different categories into which neutrophilic sets can be divided. To aid in decision-making, a trapezoidal bipolar neutrosophic quantity and its classification were created[17].

2. Definitions

Linguistic confidence interval neutrosophic number (LCINN) with Linguistic Neutrosophic Multivalued operators are introduced in this section such as[18]:

$$\eta_a(i) = \left(\left[\eta_{a^-{}_i}, \eta_{a^+{}_i}\right], \left[\eta_{b^-{}_i}, \eta_{b^+{}_i}\right], \left[\eta_{c^-{}_i}, \eta_{c^+{}_i}\right]\right) \tag{1}$$

$$LCINN\left(\eta_a(1), \eta_a(2), \dots, \eta_a(q)\right) = \bigoplus_{i=1}^{q} T^{w_i}\eta_a(i) \tag{2}$$

$$= \left(\begin{array}{c} \left[\eta_{\frac{2r}{\pi}\cos^{-1}\left(\prod_{i=1}^{q}\left(\frac{a_i^-\pi}{2r}\right)^{w_i}\right)}, \eta_{\frac{2r}{\pi}\cos^{-1}\left(\prod_{i=1}^{q}\left(\frac{a_i^+\pi}{2r}\right)^{w_i}\right)} \right], \\ \left[\eta_{\frac{2r}{\pi}\sin^{-1}\left(\prod_{i=1}^{q}\left(\frac{b_i^-\pi}{2r}\right)^{w_i}\right)}, \eta_{\frac{2r}{\pi}\sin^{-1}\left(\prod_{i=1}^{q}\left(\frac{b_i^+\pi}{2r}\right)^{w_i}\right)} \right], \\ \left[\eta_{\frac{2r}{\pi}\sin^{-1}\left(\prod_{i=1}^{q}\left(\frac{c_i^-\pi}{2r}\right)^{w_i}\right)}, \eta_{\frac{2r}{\pi}\sin^{-1}\left(\prod_{i=1}^{q}\left(\frac{c_i^+\pi}{2r}\right)^{w_i}\right)} \right] \end{array} \right) \tag{3}$$

$$LCINN\left(\eta_a(1), \eta_a(2), \dots, \eta_a(q)\right) = w_1\eta_a(1) \oplus w_2\eta_a(2) \tag{4}$$

$$= \left(\begin{bmatrix} \eta_{\frac{2r}{\pi}\cos^{-1}\left(\cos\left(\pi(2r)\times 2r/\pi\, cos^{-1}\left(\cos\left(a_1^-\pi/(2r)\right)\right)^{w_1}\right)\right)\cos\left(\frac{\pi}{2r}\times\pi\cos^{-1}\left(\cos\left(\frac{a_2^-\pi}{2r}\right)^{w_2}\right)\right)}, \\ \eta_{\frac{2r}{\pi}\cos^{-1}\left(\cos\left(\pi(2r)\times 2r/\pi\, cos^{-1}\left(\cos\left(a_1^+\pi/(2r)\right)\right)^{w_1}\right)\right)\cos\left(\frac{\pi}{2r}\times\pi\cos^{-1}\left(\cos\left(\frac{a_2^+\pi}{2r}\right)^{w_2}\right)\right)} \end{bmatrix}, \right. \\ \begin{bmatrix} \eta_{\frac{2r}{\pi}\sin^{-1}\left(\sin\left(\pi(2r)\times 2r/\pi\, sin^{-1}\left(\sin\left(b_1^-\pi/(2r)\right)\right)^{w_1}\right)\right)\sin\left(\frac{\pi}{2r}\times\pi\sin^{-1}\left(\sin\left(\frac{b_2^-\pi}{2r}\right)^{w_2}\right)\right)}, \\ \eta_{\frac{2r}{\pi}\sin^{-1}\left(\sin\left(\pi(2r)\times 2r/\pi\, sin^{-1}\left(\sin\left(b_1^+\pi/(2r)\right)\right)^{w_1}\right)\right)\sin\left(\frac{\pi}{2r}\times\pi\sin^{-1}\left(\sin\left(\frac{b_2^+\pi}{2r}\right)^{w_2}\right)\right)} \end{bmatrix}, \\ \left. \begin{bmatrix} \eta_{\frac{2r}{\pi}\sin^{-1}\left(\sin\left(\pi(2r)\times 2r/\pi\, sin^{-1}\left(\sin\left(c_1^-\pi/(2r)\right)\right)^{w_1}\right)\right)\sin\left(\frac{\pi}{2r}\times\pi\sin^{-1}\left(\sin\left(\frac{c_2^-\pi}{2r}\right)^{w_2}\right)\right)}, \\ \eta_{\frac{2r}{\pi}\sin^{-1}\left(\sin\left(\pi(2r)\times 2r/\pi\, sin^{-1}\left(\sin\left(c_1^+\pi/(2r)\right)\right)^{w_1}\right)\right)\sin\left(\frac{\pi}{2r}\times\pi\sin^{-1}\left(\sin\left(\frac{c_2^+\pi}{2r}\right)^{w_2}\right)\right)} \end{bmatrix} \right) \tag{5}$$

$$= \left(\begin{bmatrix} \eta_{\frac{2r}{\pi}\cos^{-1}\left(\left(\cos\left(a_1^-\pi/(2r)\right)\right)^{w_1}\left(\cos\left(a_2^-\pi/(2r)\right)\right)^{w_2}\right)}, \\ \eta_{\frac{2r}{\pi}\cos^{-1}\left(\left(\cos\left(a_1^+\pi/(2r)\right)\right)^{w_1}\left(\cos\left(a_2^+\pi/(2r)\right)\right)^{w_2}\right)} \end{bmatrix}, \right. \\ \begin{bmatrix} \eta_{\frac{2r}{\pi}\sin^{-1}\left(\left(\sin\left(b_1^-\pi/(2r)\right)\right)^{w_1}\left(\sin\left(b_2^-\pi/(2r)\right)\right)^{w_2}\right)}, \\ \eta_{\frac{2r}{\pi}\sin^{-1}\left(\left(\sin\left(b_1^+\pi/(2r)\right)\right)^{w_1}\left(\sin\left(b_2^+\pi/(2r)\right)\right)^{w_2}\right)} \end{bmatrix}, \\ \left. \begin{bmatrix} \eta_{\frac{2r}{\pi}\sin^{-1}\left(\left(\sin\left(c_1^-\pi/(2r)\right)\right)^{w_1}\left(\sin\left(c_2^-\pi/(2r)\right)\right)^{w_2}\right)}, \\ \eta_{\frac{2r}{\pi}\sin^{-1}\left(\left(\sin\left(c_1^+\pi/(2r)\right)\right)^{w_1}\left(\sin\left(c_2^+\pi/(2r)\right)\right)^{w_2}\right)} \end{bmatrix} \right) \tag{6}$$

$$= \left(\left[\eta_{\frac{2r}{\pi}\cos^{-1}\left(\left(\prod_{i=1}^{2}\cos\left(a_1^-\pi/(2r)\right)^{w_i}\right)\right)}, \eta_{\frac{2r}{\pi}\cos^{-1}\left(\left(\prod_{i=1}^{2}\cos\left(a_1^+\pi/(2r)\right)^{w_i}\right)\right)} \right], \right. \\ \left[\eta_{\frac{2r}{\pi}\sin^{-1}\left(\left(\prod_{i=1}^{2}\sin\left(b_1^-\pi/(2r)\right)^{w_i}\right)\right)}, \eta_{\frac{2r}{\pi}\sin^{-1}\left(\left(\prod_{i=1}^{2}\sin\left(b_1^+\pi/(2r)\right)^{w_i}\right)\right)} \right], \\ \left. \left[\eta_{\frac{2r}{\pi}\sin^{-1}\left(\left(\prod_{i=1}^{2}\sin\left(c_1^-\pi/(2r)\right)^{w_i}\right)\right)}, \eta_{\frac{2r}{\pi}\sin^{-1}\left(\left(\prod_{i=1}^{2}\sin\left(c_1^+\pi/(2r)\right)^{w_i}\right)\right)} \right] \right) \tag{7}$$

$$LCINN\left(\eta_a(1), \eta_a(2), \dots, \eta_a(q)\right) = \bigotimes_{i=1}^{q} T^{w_i}\eta_a(i) \tag{8}$$

$$= \left(\begin{bmatrix} \eta_{\frac{2r}{\pi}\sin^{-1}\left(\sin\left(\pi(2r)\times 2r/\pi\,\sin^{-1}\left(\sin\left(a_1^-\pi/(2r)\right)\right)^{w_1}\right)\right)\sin\left(\frac{\pi}{2r}\times\pi\sin^{-1}\left(\sin\left(\frac{a_2^-\pi}{2r}\right)^{w_2}\right)\right)}, \\ \eta_{\frac{2r}{\pi}\sin^{-1}\left(\sin\left(\pi(2r)\times 2r/\pi\,\sin^{-1}\left(\sin\left(a_1^+\pi/(2r)\right)\right)^{w_1}\right)\right)\sin\left(\frac{\pi}{2r}\times\pi\sin^{-1}\left(\sin\left(\frac{a_2^+\pi}{2r}\right)^{w_2}\right)\right)} \end{bmatrix}, \right. \\ \begin{bmatrix} \eta_{\frac{2r}{\pi}\cos^{-1}\left(\cos\left(\pi(2r)\times 2r/\pi\, sin^{-1}\left(\cos\left(b_1^-\pi/(2r)\right)\right)^{w_1}\right)\right)\cos\left(\frac{\pi}{2r}\times\pi\cos^{-1}\left(\cos\left(\frac{b_2^-\pi}{2r}\right)^{w_2}\right)\right)}, \\ \eta_{\frac{2r}{\pi}\cos^{-1}\left(\cos\left(\pi(2r)\times 2r/\pi\, sin^{-1}\left(\cos\left(b_1^+\pi/(2r)\right)\right)^{w_1}\right)\right)\cos\left(\frac{\pi}{2r}\times\pi\cos^{-1}\left(\cos\left(\frac{b_2^+\pi}{2r}\right)^{w_2}\right)\right)} \end{bmatrix}, \\ \left. \begin{bmatrix} \eta_{\frac{2r}{\pi}\cos^{-1}\left(\cos\left(\pi(2r)\times 2r/\pi\, sin^{-1}\left(\cos\left(c_1^-\pi/(2r)\right)\right)^{w_1}\right)\right)\cos\left(\frac{\pi}{2r}\times\pi\cos^{-1}\left(\cos\left(\frac{c_2^-\pi}{2r}\right)^{w_2}\right)\right)}, \\ \eta_{\frac{2r}{\pi}\cos^{-1}\left(\cos\left(\pi(2r)\times 2r/\pi\, sin^{-1}\left(\cos\left(c_1^+\pi/(2r)\right)\right)^{w_1}\right)\right)\cos\left(\frac{\pi}{2r}\times\pi\cos^{-1}\left(\cos\left(\frac{c_2^+\pi}{2r}\right)^{w_2}\right)\right)} \end{bmatrix} \right) \tag{9}$$

$$= \left(\begin{bmatrix} \eta\frac{2r}{\pi}\sin^{-1}\left((\sin(a_1^-\pi/(2r)))^{w_1}(\sin(a_2^-\pi/(2r)))^{w_2}\right), \\ \eta\frac{2r}{\pi}\sin^{-1}\left((\sin(a_1^+\pi/(2r)))^{w_1}(\sin(a_2^+\pi/(2r)))^{w_2}\right) \end{bmatrix}, \begin{bmatrix} \eta\frac{2r}{\pi}\cos^{-1}\left((\cos(b_1^-\pi/(2r)))^{w_1}(\cos(b_2^-\pi/(2r)))^{w_2}\right), \\ \eta\frac{2r}{\pi}\cos^{-1}\left((\cos(b_1^+\pi/(2r)))^{w_1}(\cos(b_2^+\pi/(2r)))^{w_2}\right) \end{bmatrix}, \begin{bmatrix} \eta\frac{2r}{\pi}\cos^{-1}\left((\cos(c_1^-\pi/(2r)))^{w_1}(\cos(c_2^-\pi/(2r)))^{w_2}\right), \\ \eta\frac{2r}{\pi}\cos^{-1}\left((\cos(c_1^+\pi/(2r)))^{w_1}(\cos(c_2^+\pi/(2r)))^{w_2}\right) \end{bmatrix} \right) \tag{10}$$

$$= \left(\begin{bmatrix} \eta\frac{2r}{\pi}\sin^{-1}\left(\left(\prod_{i=1}^{2}\sin(a_1^-\pi/(2r)))^{w_i}\right)\right), \eta\frac{2r}{\pi}\sin^{-1}\left(\left(\prod_{i=1}^{2}\sin(a_1^+\pi/(2r)))^{w_i}\right)\right) \end{bmatrix}, \begin{bmatrix} \eta\frac{2r}{\pi}\cos^{-1}\left(\left(\prod_{i=1}^{2}\cos(b_1^-\pi/(2r)))^{w_i}\right)\right), \eta\frac{2r}{\pi}\cos^{-1}\left(\left(\prod_{i=1}^{2}\cos(b_1^+\pi/(2r)))^{w_i}\right)\right) \end{bmatrix}, \begin{bmatrix} \left[\eta\frac{2r}{\pi}\cos^{-1}\left(\left(\prod_{i=1}^{2}\cos(c_1^-\pi/(2r)))^{w_i}\right)\right), \eta\frac{2r}{\pi}\cos^{-1}\left(\left(\prod_{i=1}^{2}\cos(c_1^+\pi/(2r)))^{w_i}\right)\right) \end{bmatrix} \right) \tag{11}$$

This part shows the steps of the RAM method to obtain the rank of alternatives. We use LCINN to evaluate the criteria and alternatives and obtain the criteria weights by the average method from the decision matrix.

Compute the normalized decision matrix.

$$y_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}} \tag{12}$$

Compute the weighted decision matrix.

$$U_j = y_{ij} w_j \tag{13}$$

Compute the numbers of positive and negative criteria

$$A_{+i} = \sum_{j=1}^{n} U_{+ij} \tag{14}$$

$$B_{-i} = \sum_{j=1}^{n} U_{-ij} \tag{15}$$

Calculate the overall score of each alternative.

$$H_i = \sqrt[2+B_{-i}]{2 + A_{+i}} \tag{16}$$

3. Results and Discussion

This study uses eight criteria and eight alternatives to be evaluated. The criteria are AI Feedback Precision, Real-Time Adaptive Instruction, Cognitive Engagement, Writing Style Development, Integration with Interdisciplinary Content, Learner Autonomy Support, Educator-AI Collaboration Effectiveness, Inclusivity and Personalization. The alternatives are AI-Powered Writing Tutors, NLP-Based Essay Evaluation Systems, Peer Review Platforms Enhanced by AI Analytics, Interactive Writing Simulations, Multimodal Writing Assessment Platforms,

Personalized Writing Dashboards with Predictive Feedback, AI-Driven Curriculum Mapping Tools, Contextual Writing Prompts Generator Based on Data Mining.

Four experts are evaluated the criteria and alternatives as shown in Table 1-4. Experts used LCINN to evaluate the criteria and alternatives. We combine the decision matrix as shown in Fig 1 Then we obtain the criteria weights as shown in Fig 2.

Table 1. The first decision matrix.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
A_1	<[η4.0666, η5.5334], [η1.6160, η3.1840], [η2.1199, η3.0801]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η4.9199, η5.8801], [η1.4666, η2.9334], [η1.3802, η2.6198]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>
A_2	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>
A_3	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>
A_4	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η4.9199, η5.8801], [η1.4666, η2.9334], [η1.3802, η2.6198]>	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η4.9199, η5.8801], [η1.4666, η2.9334], [η1.3802, η2.6198]>	<[η4.9199, η5.8801], [η1.4666, η2.9334], [η1.3802, η2.6198]>
A_5	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>
A_6	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>
A_7	<[η4.0666, η5.5334], [η1.6160, η3.1840], [η2.1199, η3.0801]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η4.0666, η5.5334], [η1.6160, η3.1840], [η2.1199, η3.0801]>	<[η4.9199, η5.8801], [η1.4666, η2.9334], [η1.3802, η2.6198]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>
A_8	<[η4.0666, η5.5334], [η1.6160, η3.1840], [η2.1199, η3.0801]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>

Table 2. The second decision matrix.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
A_1	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η4.9199, η5.8801], [η1.4666, η2.9334], [η1.3802, η2.6198]>	<[η4.0666, η5.5334], [η1.6160, η3.1840], [η2.1199, η3.0801]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>
A_2	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η4.0666, η5.5334], [η1.6160, η3.1840], [η2.1199, η3.0801]>	<[η4.9199, η5.8801], [η1.4666, η2.9334], [η1.3802, η2.6198]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>
A_3	<[η4.0666, η5.5334], [η1.6160, η3.1840], [η2.1199, η3.0801]>	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η4.9199, η5.8801], [η1.4666, η2.9334], [η1.3802, η2.6198]>	<[η4.0666, η5.5334], [η1.6160, η3.1840], [η2.1199, η3.0801]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η4.9199, η5.8801], [η1.4666, η2.9334], [η1.3802, η2.6198]>
A_4	<[η4.9199, η5.8801], [η1.4666, η2.9334], [η1.3802, η2.6198]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η4.0666, η5.5334], [η1.6160, η3.1840], [η2.1199, η3.0801]>
A_5	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η4.0666, η5.5334], [η1.6160, η3.1840], [η2.1199, η3.0801]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η4.9199, η5.8801], [η1.4666, η2.9334], [η1.3802, η2.6198]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>
A_6	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>	<[η4.9199, η5.8801], [η1.4666, η2.9334], [η1.3802, η2.6198]>	<[η4.0666, η5.5334], [η1.6160, η3.1840], [η2.1199, η3.0801]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η4.0666, η5.5334], [η1.6160, η3.1840], [η2.1199, η3.0801]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η4.0666, η5.5334], [η1.6160, η3.1840], [η2.1199, η3.0801]>
A_7	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η4.9199, η5.8801], [η1.4666, η2.9334], [η1.3802, η2.6198]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>
A_8	<[η4.0080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>	<[η4.9199, η5.8801], [η1.4666, η2.9334], [η1.3802, η2.6198]>	<[η4.0666, η5.5334], [η1.6160, η3.1840], [η2.1199, η3.0801]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η4.0666, η5.5334], [η1.6160, η3.1840], [η2.1199, η3.0801]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η4.0666, η5.5334], [η1.6160, η3.1840], [η2.1199, η3.0801]>

Table 3. The third decision matrix.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
A_1	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η4.9199, η5.8801], [η1.4666, η2.9334], [η1.3802, η2.6198]>	<[η4.0666, η5.5334], [η1.6160, η3.1840], [η2.1199, η3.0801]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>
A_2	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η4.0666, η5.5334], [η1.6160, η3.1840], [η2.1199, η3.0801]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>
A_3	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>	<[η4.9199, η5.8801], [η1.4666, η2.9334], [η1.3802, η2.6198]>
A_4	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η4.0666, η5.5334], [η1.6160, η3.1840], [η2.1199, η3.0801]>
A_5	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η4.9199, η5.8801], [η1.4666, η2.9334], [η1.3802, η2.6198]>
A_6	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η4.0666, η5.5334], [η1.6160, η3.1840], [η2.1199, η3.0801]>
A_7	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>	<[η4.9199, η5.8801], [η1.4666, η2.9334], [η1.3802, η2.6198]>
A_8	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η4.9199, η5.8801], [η1.4666, η2.9334], [η1.3802, η2.6198]>	<[η4.0666, η5.5334], [η1.6160, η3.1840], [η2.1199, η3.0801]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η4.0666, η5.5334], [η1.6160, η3.1840], [η2.1199, η3.0801]>

Table 4. The fourth decision matrix.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
A_1	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η4.9199, η5.8801], [η1.4666, η2.9334], [η1.3802, η2.6198]>	<[η4.0666, η5.5334], [η1.6160, η3.1840], [η2.1199, η3.0801]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>
A_2	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η4.0666, η5.5334], [η1.6160, η3.1840], [η2.1199, η3.0801]>	<[η4.9199, η5.8801], [η1.4666, η2.9334], [η1.3802, η2.6198]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>
A_3	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η4.9199, η5.8801], [η1.4666, η2.9334], [η1.3802, η2.6198]>	<[η4.0666, η5.5334], [η1.6160, η3.1840], [η2.1199, η3.0801]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η4.9199, η5.8801], [η1.4666, η2.9334], [η1.3802, η2.6198]>
A_4	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>	<[η4.0666, η5.5334], [η1.6160, η3.1840], [η2.1199, η3.0801]>
A_5	<[η4.9199, η5.8801], [η1.4666, η2.9334], [η1.3802, η2.6198]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>
A_6	<[η4.9199, η5.8801], [η1.4666, η2.9334], [η1.3802, η2.6198]>	<[η4.9199, η5.8801], [η1.4666, η2.9334], [η1.3802, η2.6198]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η4.9199, η5.8801], [η1.4666, η2.9334], [η1.3802, η2.6198]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η4.0666, η5.5334], [η1.6160, η3.1840], [η2.1199, η3.0801]>	<[η4.9199, η5.8801], [η1.4666, η2.9334], [η1.3802, η2.6198]>	<[η4.0666, η5.5334], [η1.6160, η3.1840], [η2.1199, η3.0801]>
A_7	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η4.9199, η5.8801], [η1.4666, η2.9334], [η1.3802, η2.6198]>	<[η4.0666, η5.5334], [η1.6160, η3.1840], [η2.1199, η3.0801]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>
A_8	<[η5.1199, η6.0801], [η1.1199, η2.0801], [η0.9199, η1.8801]>	<[η5.8080, η6.5920], [η1.3802, η2.6198], [η1.1235, η2.8765]>	<[η5.4080, η6.1920], [η1.4666, η2.9334], [η0.8160, η2.3840]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>	<[η4.9199, η5.8801], [η1.4666, η2.9334], [η1.3802, η2.6198]>	<[η4.0666, η5.5334], [η1.6160, η3.1840], [η2.1199, η3.0801]>	<[η5.3802, η6.6198], [η0.9199, η1.8801], [η0.9199, η1.8801]>	<[η5.1199, η6.0801], [η1.6160, η3.1840], [η1.3802, η2.6198]>

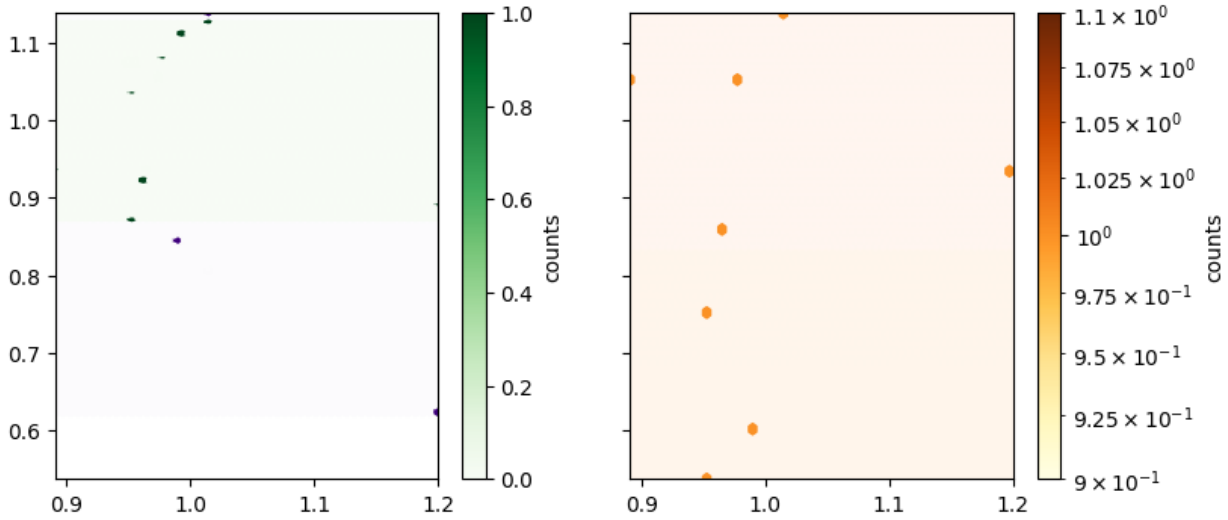

Fig 1. The combined decision matrix.

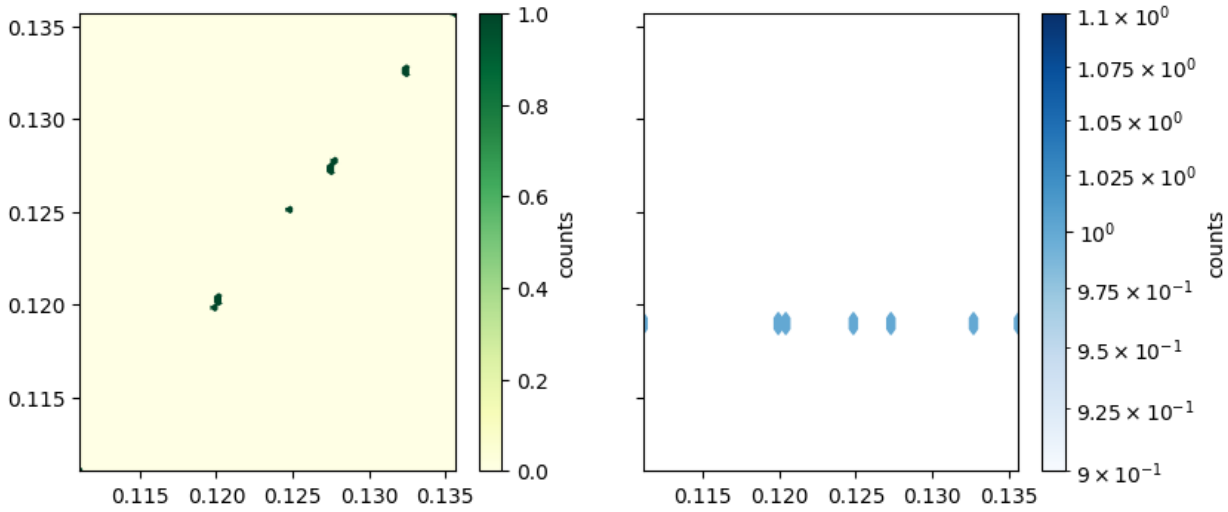

Fig 2. The criteria weights.

Eq. (12) is used to compute the normalized decision matrix as shown in Fig 3.

Eq. (13) is used to compute the weighted decision matrix as shown in Fig 4.

Eqs. (14 and 15) is used to compute the numbers of positive and negative criteria as shown in Fig 5.

Eq. (16) is used to calculate the overall score of each alternative as shown in Fig 6. Then we rank the alternatives as shown in Fig 7.

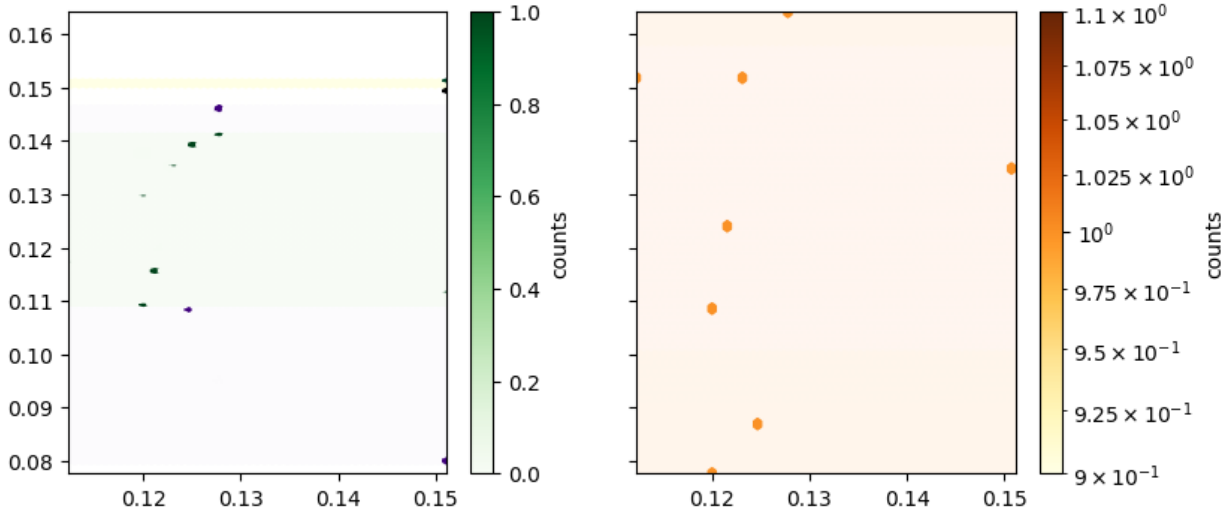

Fig 3. The normalized decision matrix.

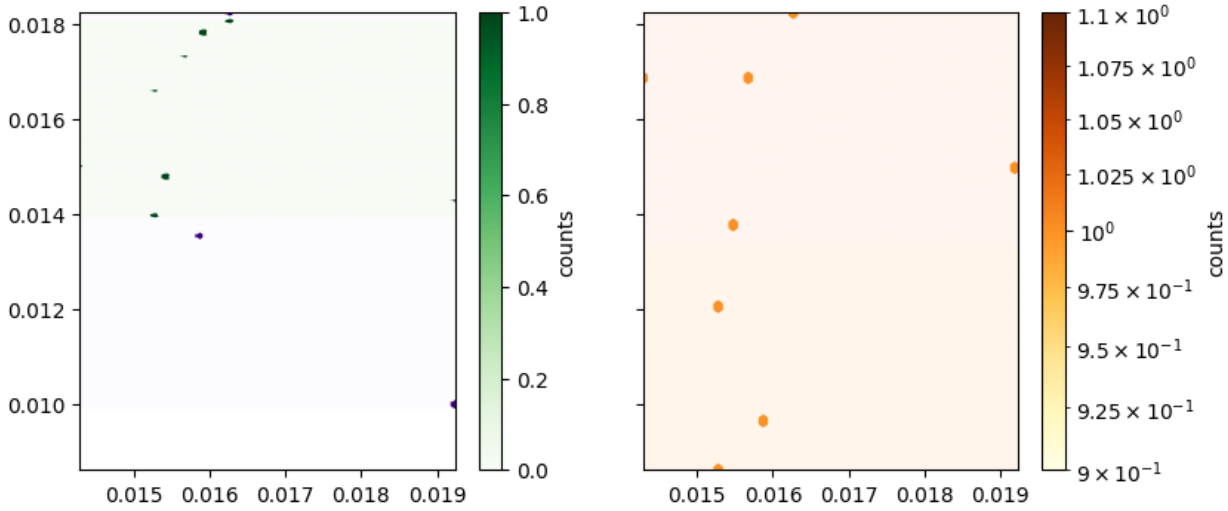

Fig 4. The weighted decision matrix.

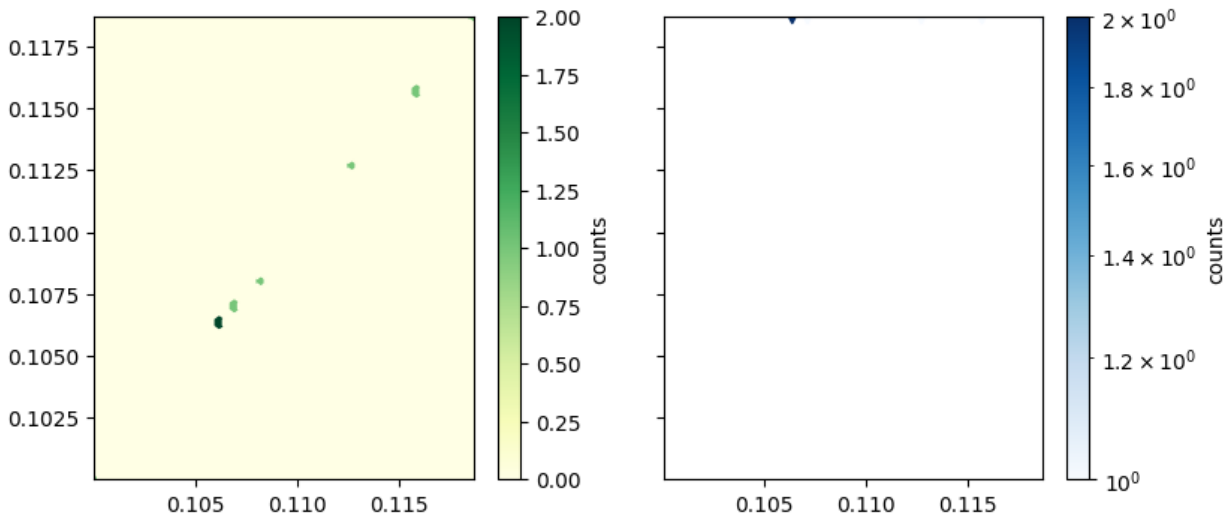

Fig 5. The numbers of positive and negative criteria.

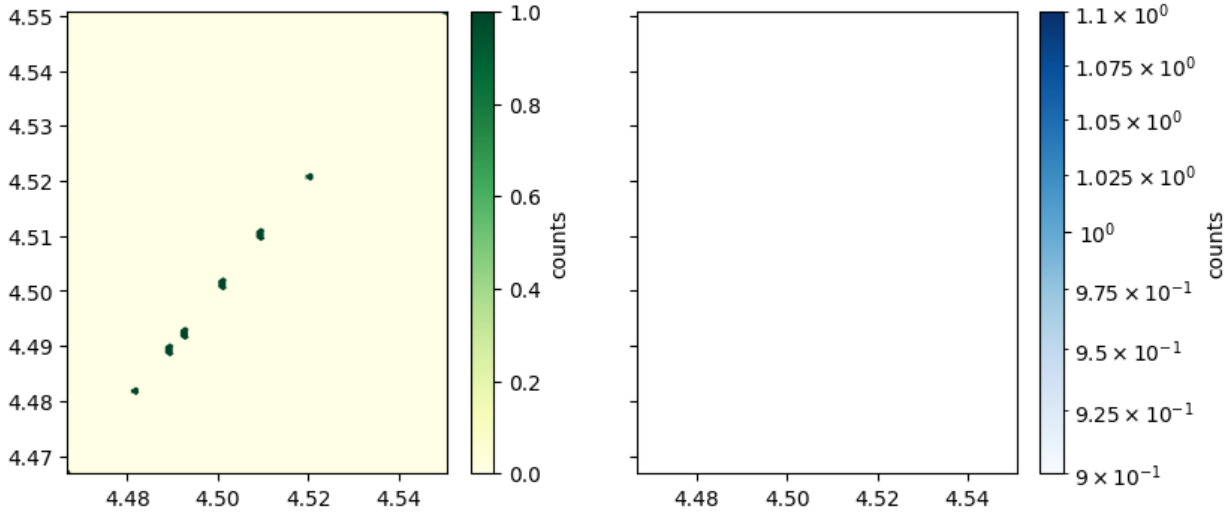

Fig 6. The overall score of each alternative.

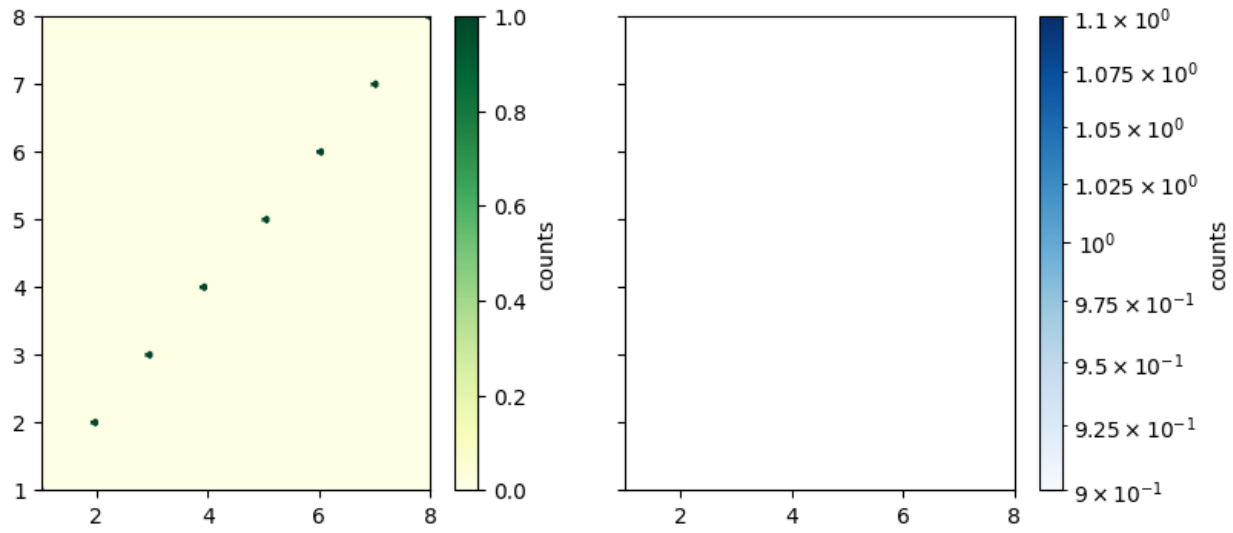

Fig 7. The rank of alternatives.

4. Sensitivity Analysis

This section shows the sensitivity analysis by changing the criteria weights and then ranking the alternatives. We change the criteria weights by nine cases as shown in Fig 8. We put all criteria with equal weights. Then we increased the criteria weights by 0.167. Then we propose nine cases in the criteria weights.

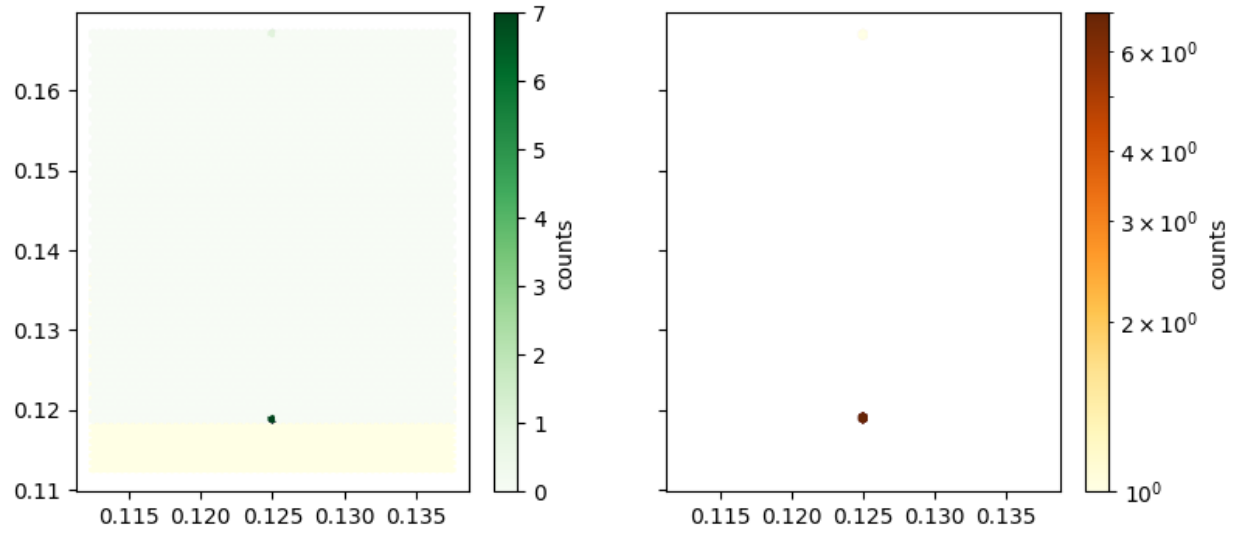

Fig 8. Different criteria weights.

We apply the RAM method under different criteria weights. We show the different values of positive and negative criteria under the sensitivity analysis as shown in Fig 9 and 10. Then we

rank the alternatives. We show the overall score of each alternative under different weights as shown in Fig 11. We rank the alternatives as shown in Fig 12. The results show the proposed approach is stable under different criteria weights.

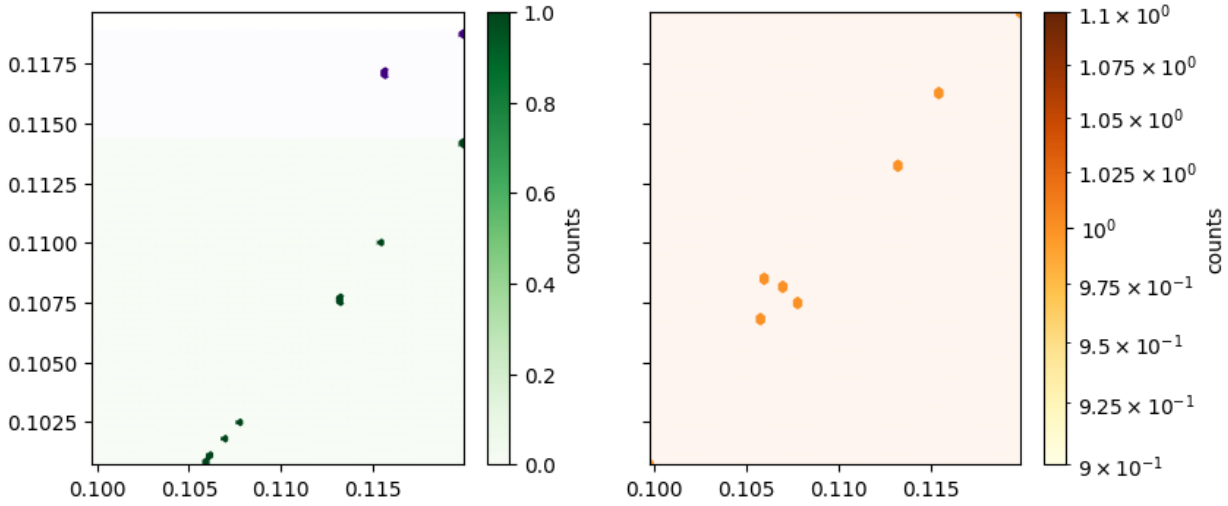

Fig 9. The different values of positive criteria.

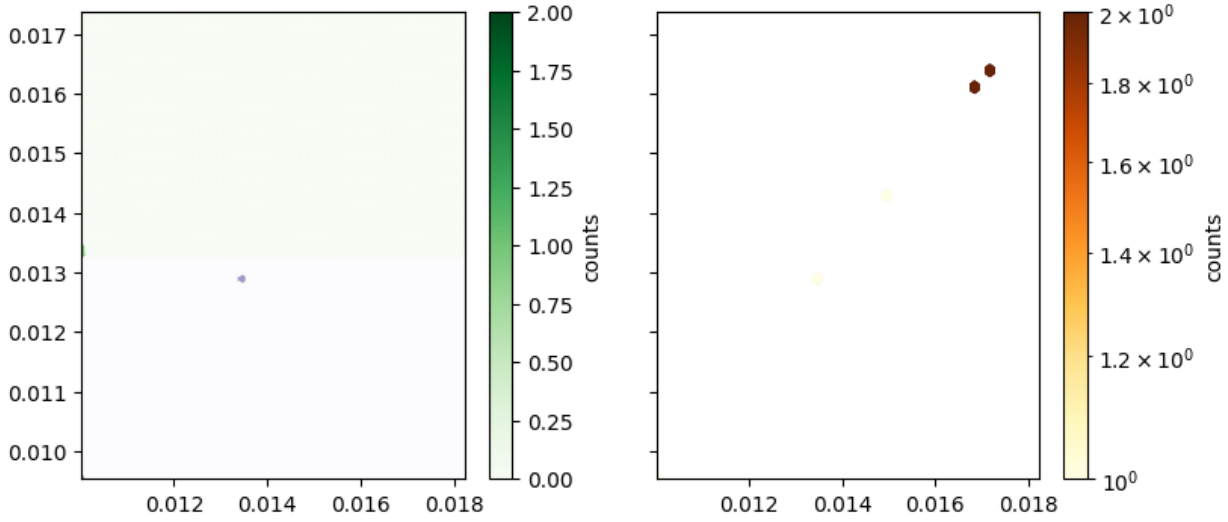

Fig 10. The different values of negative criteria.

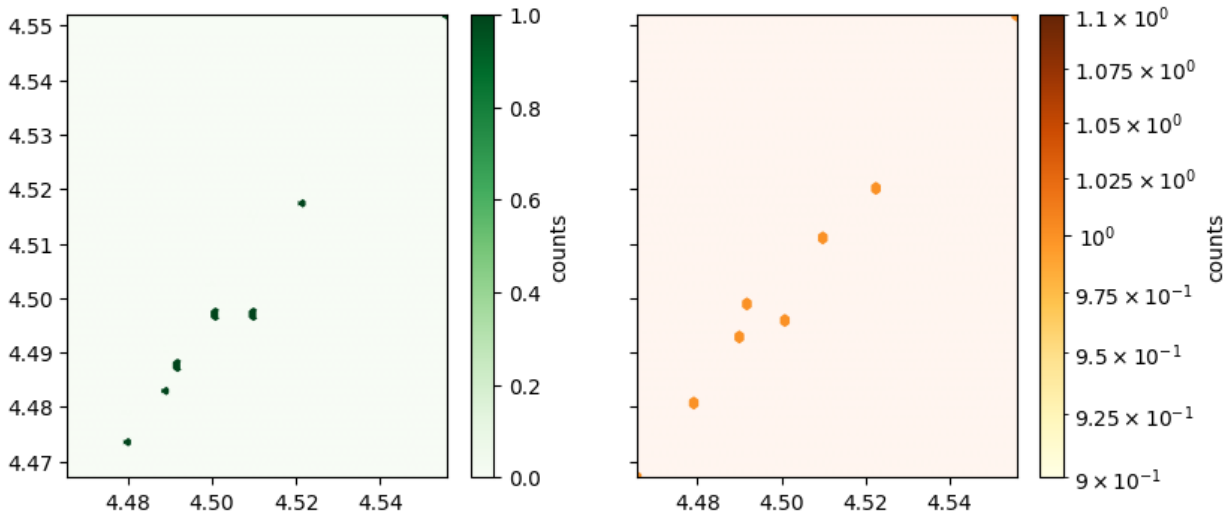

Fig 11. The different overall score.

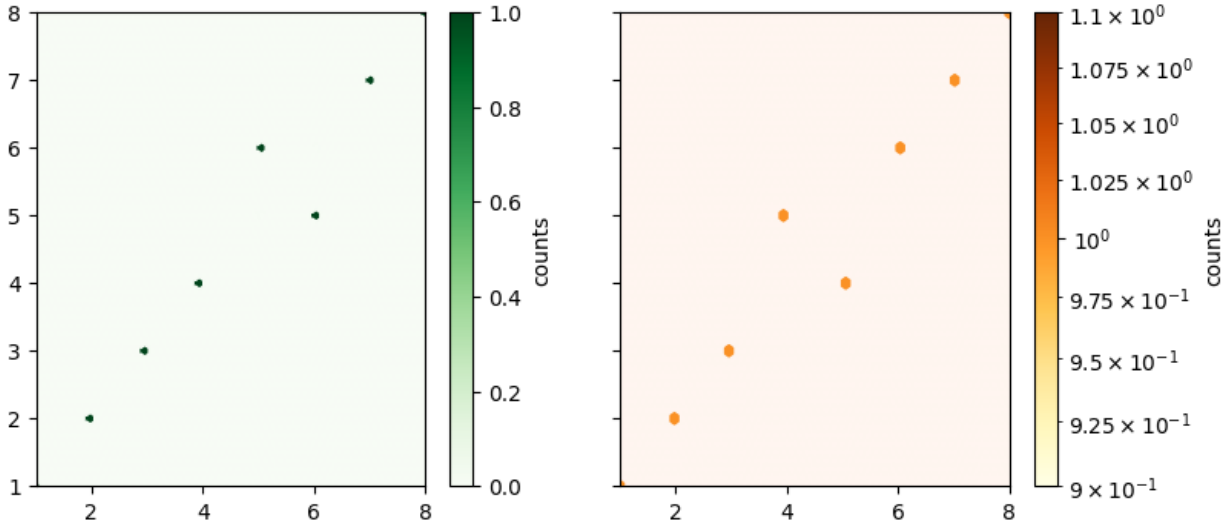

Fig 12. The different ranks of alternatives.

5. Conclusions and Future Works

The integration of Artificial Intelligence within the framework of the New Liberal Arts offers transformative potential for university English writing instruction. This research provides a structured evaluation model to assess quality across multiple pedagogical and technological dimensions. Through eight well-defined criteria and alternatives, institutions can navigate the complexity of modern writing education, ensuring both academic rigor and learner-centric engagement. We used the RAM methodology to rank alternatives. The neutrosophic set is used

to deal with uncertainty information. The sensitivity analysis is conducted to show the different ranks of the alternatives. The results show the rank of alternatives is stable in different cases.

As educational paradigms continue to shift toward interdisciplinary and technology-enhanced models, this framework enables sustained innovation, helping educators not just teach writing, but cultivate articulate, analytical, and adaptive communicators for the future

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