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Probabilistic Single-Valued Neutrosophic Operator for Optimizing Teaching Outcomes in University Career Planning Courses Using AI Evaluation Models

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Abstract: AI integration into university career planning courses has emerged as a crucial step toward individualized and successful student development in the rapidly changing higher education landscape. This project investigates using AI-driven assessment models to optimize teaching results in career planning at the university level. The efficacy of several teaching strategies was evaluated using eight major criteria, such as engagement, AI-driven feedback, career target clarity, and flexibility to meet the requirements of individual students. Data was gathered from a variety of instructional options, including AI-enhanced virtual simulations and conventional lectures. These choices were ranked and evaluated using neutrosophic set. The single valued neutrosophic set (SVNS) is used to solve uncertainty information. We combine Probabilistic with SVNS to deal with uncertainty information. The findings show that AI-integrated teaching models perform noticeably better than traditional approaches in terms of providing individualized career counseling, raising student happiness, and coordinating education with the needs of the labor market. The results give educators and policymakers a framework for using intelligent technology to improve the caliber and effectiveness of career planning education.

Keywords: Probabilistic Single-Valued Neutrosophic; Teaching Outcomes; University Career Planning; AI Evaluation Models.

1. Introduction

The complex systems of modern life necessitate uncertainties in the face of indeterminacy; as a result, the current sets, FS or IFS, are unable to handle the information appropriately. Smarandache [1] introduced the neutrosophic set (NS) in 1998 by combining the three independent functions of "acceptance," "indeterminacy," and "non-acceptance," which represent the standard or non-standard real subset, respectively.

However, the traditional unit interval [0, 1] is utilized for software engineering proposals and in real-world decision-making situations. Accordingly, Wang et al. enrich the NS to single-valued NS (SVNS), and Wang et al. enrich the NS to interval neutrosophic set (INS), where the independent degree ranges are assumed to be [0, 1][2], [3].

1.1 Related Work

Students' unique requirements are not adequately met by vocational institutions' standard teaching and career planning methods, which results in ineffective resource allocation, little specialized instruction, and a dearth of dynamic adjustment mechanisms. Their potential development is further hampered by limitations on course choices and mismatches between students and courses. Luo et al. [4] looked at how artificial intelligence (AI) is being used in vocational education and offers a customized framework for skill development and career planning. They presented a concept to enhance teaching quality and assist the digital transformation of vocational institutions by highlighting AI's involvement in career paths, elective customization, employment feedback, and course optimization.

Xu [5] explored the use of artificial intelligence (AI) optimization algorithms in individualized instruction and higher education administration. The potential, efficacy, and difficulties of incorporating AI algorithms into educational processes and systems are investigated through a thorough literature review, theoretical analysis, and practical investigation. He shows that AI optimization algorithms can enable tailored learning experiences and successfully resolve challenging educational management issues. Comparing AI-driven individualized education to conventional methods, empirical research spanning one academic semester demonstrates notable gains in students' learning results, engagement, satisfaction, and efficiency.

He points up drawbacks and restrictions, such as algorithmic bias, data privacy concerns, and the requirement for human-AI communication. The significance of creating more adaptable algorithms, looking into long-term consequences, and creating ethical frameworks for AI in education are all emphasized in the recommendations for future research areas.

Huang et al. [6] examined the value and potential uses of the adaptive artificial intelligence-based customized intelligent education system for college students' career planning. The system provides personalized career planning services by integrating big data analysis and cloud computing technologies with deep learning and natural language processing technologies to accurately evaluate pupils. In addition to helping students better understand the market and themselves, the system may offer them individualized coaching and a wealth of educational tools to increase the efficacy and scientific of career planning. The establishment of this system not only creates a new avenue for career education innovation and growth, but it also offers robust support for students' professional development.

According to experiments, the methodology developed in this study has a 90% job satisfaction rate and an 85% job-seeking success rate for students. These figures are far higher than the 70%

and 65% of the conventional approach, respectively. The system may successfully support the advancement of career education and serves as a vital link between students, institutions, and businesses.

2. Probabilistic Single-Valued Neutrosophic

This section shows definition of single valued neutrosophic set (SVNS) with probabilistic operators[7].

Definition 1

The neutrosophic set can be defined as:

$$S = \left\{\left(d, \left(T_S(d), I_S(d), F_S(d)\right)\right) \mid d \in D\right\}$$

$$T_S(d), I_S(d), F_S(d): D \rightarrow]0^-, 1^+$$

Definition 2

The weighted average operators of SVNS can be defined as:

$$SVNWA(S_1, S_2, \dots, S_n) = \begin{pmatrix} 1 - \prod_{j=1}^{n} \left(1 - T_S(d)\right)^{w_j}, \\ \prod_{j=1}^{n} \left(I_S(d)\right)^{w_j}, \\ \prod_{j=1}^{n} \left(F_S(d)\right)^{w_j} \end{pmatrix}$$

Definition 3

The weighted geometric operators of SVNS can be defined as:

$$SVNWG(S_1, S_2, \dots, S_n) = \begin{pmatrix} \prod_{j=1}^{n} \left(T_S(d)\right)^{w_j}, \\ 1 - \prod_{j=1}^{n} \left(1 - I_S(d)\right)^{w_j}, \\ 1 - \prod_{j=1}^{n} \left(1 - F_S(d)\right)^{w_j} \end{pmatrix}$$

Definition 4

The ordered weighted average operators of SVNS can be defined as:

$$SVNOWA(S_1, S_2, \dots, S_n) = \begin{pmatrix} 1 - \prod_{j=1}^{n} \left(1 - T_S(d)\right)^{w_j}, \\ \prod_{j=1}^{n} \left(I_S(d)\right)^{w_j}, \\ \prod_{j=1}^{n} \left(F_S(d)\right)^{w_j} \end{pmatrix}$$

Definition 5

The ordered weighted geometric operators of SVNS can be defined as:

$$SVNOWG(S_1, S_2, \dots, S_n) = \begin{pmatrix} \prod_{j=1}^{n} \left(T_S(d)\right)^{w_j}, \\ 1 - \prod_{j=1}^{n} \left(1 - I_S(d)\right)^{w_j}, \\ 1 - \prod_{j=1}^{n} \left(1 - F_S(d)\right)^{w_j} \end{pmatrix}$$

Definition 6

The Probabilistic single-valued neutrosophic weighted average operator can be defined as:

$$P - SVNWA(S_1, S_2, \dots, S_n) = \bigoplus_{j=1}^{n} v_j S_j$$

$$P - SVNWA(S_1, S_2, \dots, S_n) = \begin{pmatrix} 1 - \prod_{j=1}^{n} \left(1 - T_S(d)\right)^{v_j}, \\ \prod_{j=1}^{n} \left(I_S(d)\right)^{v_j}, \\ \prod_{j=1}^{n} \left(F_S(d)\right)^{v_j} \end{pmatrix}$$

$$\sum_{j=1}^{n} v_j = 1$$

Definition 7

The Immediate probability single-valued neutrosophic ordered weighted operator can be defined as:

$$IP-SVNOWA(S_1,S_2,\dots,S_n)=\begin{pmatrix} 1-\prod_{j=1}^{n}\left(1-T_S(d)\right)^{p_j}, \\ \prod_{j=1}^{n}\left(I_S(d)\right)^{p_j}, \\ \prod_{j=1}^{n}\left(F_S(d)\right)^{p_j} \end{pmatrix}$$

$$P-SVNOWA(S_1,S_2,\dots,S_n)=\begin{pmatrix} 1-\prod_{j=1}^{n}\left(1-T_S(d)\right)^{v_j}, \\ \prod_{j=1}^{n}\left(I_S(d)\right)^{v_j}, \\ \prod_{j=1}^{n}\left(F_S(d)\right)^{v_j} \end{pmatrix}$$

Definition 8

The Probabilistic single-valued neutrosophic weighted geometric operator can be defined as:

$$P-SVNWG(S_1,S_2,\dots,S_n)=\begin{pmatrix} \prod_{j=1}^{n}\left(T_S(d)\right)^{v_j}, \\ 1-\prod_{j=1}^{n}\left(1-I_S(d)\right)^{v_j}, \\ 1-\prod_{j=1}^{n}\left(1-F_S(d)\right)^{v_j} \end{pmatrix}$$

$$P-SVNOWG(S_1,S_2,\dots,S_n)=\begin{pmatrix} \prod_{j=1}^{n}\left(T_S(d)\right)^{p_j}, \\ 1-\prod_{j=1}^{n}\left(1-I_S(d)\right)^{p_j}, \\ 1-\prod_{j=1}^{n}\left(1-F_S(d)\right)^{p_j} \end{pmatrix}$$

3. Proposed Algorithm

This section shows the proposed algorithm steps for Optimizing Teaching Outcomes in University Career Planning Using AI Evaluation Models under neutrosophic set to solve uncertainty and vague information. Let a set of alternatives such as $SVOA =$

$\{SVOA_1, SVOA_2, SVOA_3, \dots, SVOA_m\}$. Let a set of criteria such as $SVOC = \{SVOC_1, SVOC_2, SVOC_3, \dots, SVOC_n\}$.

Step 1. Experts and decision makers can evaluate the criteria and alternatives using the SVNS $\left(T_S(d), I_S(d), F_S(d)\right)$. While $T_S(d), I_S(d), F_S(d) \in [0,1]$ and $T_S(d) + I_S(d) + F_S(d) \leq 3$.

Step 2. Set the probabilistic information.

Step 3. Combine the evaluation of experts and decision makers using the SVN operators.

Step 4. Compute the score value of each alternative.

$$S(D) = \frac{2 + T_S(d) - I_S(d) - F_S(d)}{3}$$

Step 5. Rank the alternatives based on the score values.

4. Numerical Example

This section shows the results of the proposed algorithm to show the ranks of the alternatives under SVNS. This study proposed algorithm for Optimizing Teaching Outcomes in University Career Planning Using AI Evaluation Models. This study uses eight criteria and eight alternatives such as: Clarity of Career Objectives Presented, Use of AI-Enhanced Feedback Tools, Student Engagement and Interactivity, Relevance of Course Content to Job Market Trends, Integration of AI-Powered Career Simulations and Scenarios, Assessment and Evaluation Methods, Adaptability to Individual Student Needs Using AI Personalization, Student Satisfaction with Guidance and Mentorship Support. The alternatives are: Traditional Lectures with Manual Assessments, Career Planning, Course with AI-Powered Resume Builders and Job Match Systems, Blended Learning with Virtual Career Labs, Fully Online Career Course Integrated with AI Mentoring Bots, Peer-Led Career Workshops with AI-Analyzed Performance Feedback, Interactive Web-Based Modules with Real-Time Skill Gap Analysis, AI-Based Adaptive Career Pathway Learning System, Case-Based Learning Approach with Predictive Analytics on Student Progress.

Three experts evaluate the criteria and alternatives as shown in Table 1. The experts use the SVN to evaluate the criteria and alternatives. They used three membership functions.

Table 1. SVNS.

	$SVOC_1$	$SVOC_2$	$SVOC_3$	$SVOC_4$	$SVOC_5$	$SVOC_6$	$SVOC_7$	$SVOC_8$
$SVOA_1$	(0.5,0.3,0.4)	(0.7,0.1,0.3)	(0.4,0.1,0.3)	(0.6,0.2,0.4)	(0.3,0.2,0.4)	(0.9,0.2,0.1)	(0.1,0.8,0.9)	(0.4,0.1,0.3)
$SVOA_2$	(0.5,0.3,0.4)	(0.1,0.8,0.9)	(0.9,0.2,0.1)	(0.3,0.2,0.4)	(0.6,0.2,0.4)	(0.4,0.1,0.3)	(0.5,0.3,0.4)	(0.6,0.2,0.4)
$SVOA_3$	(0.7,0.1,0.3)	(0.4,0.1,0.3)	(0.6,0.2,0.4)	(0.3,0.2,0.4)	(0.9,0.2,0.1)	(0.7,0.1,0.3)	(0.7,0.1,0.3)	(0.3,0.2,0.4)
$SVOA_4$	(0.6,0.2,0.4)	(0.4,0.1,0.3)	(0.7,0.1,0.3)	(0.5,0.3,0.4)	(0.1,0.8,0.9)	(0.5,0.3,0.4)	(0.4,0.1,0.3)	(0.9,0.2,0.1)
$SVOA_5$	(0.3,0.2,0.4)	(0.6,0.2,0.4)	(0.4,0.1,0.3)	(0.7,0.1,0.3)	(0.5,0.3,0.4)	(0.1,0.8,0.9)	(0.6,0.2,0.4)	(0.1,0.8,0.9)
$SVOA_6$	(0.3,0.2,0.4)	(0.3,0.2,0.4)	(0.6,0.2,0.4)	(0.3,0.2,0.4)	(0.1,0.8,0.9)	(0.9,0.2,0.1)	(0.3,0.2,0.4)	(0.9,0.2,0.1)
$SVOA_7$	(0.9,0.2,0.1)	(0.1,0.8,0.9)	(0.7,0.1,0.3)	(0.1,0.8,0.9)	(0.3,0.2,0.4)	(0.6,0.2,0.4)	(0.1,0.8,0.9)	(0.7,0.1,0.3)
$SVOA_8$	(0.1,0.8,0.9)	(0.5,0.3,0.4)	(0.5,0.3,0.4)	(0.5,0.3,0.4)	(0.6,0.2,0.4)	(0.4,0.1,0.3)	(0.5,0.3,0.4)	(0.1,0.8,0.9)
	$SVOC_1$	$SVOC_2$	$SVOC_3$	$SVOC_4$	$SVOC_5$	$SVOC_6$	$SVOC_7$	$SVOC_8$
$SVOA_1$	(0.6,0.2,0.4)	(0.7,0.1,0.3)	(0.4,0.1,0.3)	(0.6,0.2,0.4)	(0.3,0.2,0.4)	(0.9,0.2,0.1)	(0.1,0.8,0.9)	(0.4,0.1,0.3)
$SVOA_2$	(0.4,0.1,0.3)	(0.1,0.8,0.9)	(0.9,0.2,0.1)	(0.6,0.2,0.4)	(0.6,0.2,0.4)	(0.4,0.1,0.3)	(0.6,0.2,0.4)	(0.6,0.2,0.4)
$SVOA_3$	(0.7,0.1,0.3)	(0.4,0.1,0.3)	(0.6,0.2,0.4)	(0.4,0.1,0.3)	(0.6,0.2,0.4)	(0.7,0.1,0.3)	(0.4,0.1,0.3)	(0.3,0.2,0.4)
$SVOA_4$	(0.5,0.3,0.4)	(0.4,0.1,0.3)	(0.7,0.1,0.3)	(0.7,0.1,0.3)	(0.4,0.1,0.3)	(0.5,0.3,0.4)	(0.7,0.1,0.3)	(0.9,0.2,0.1)
$SVOA_5$	(0.1,0.8,0.9)	(0.6,0.2,0.4)	(0.4,0.1,0.3)	(0.5,0.3,0.4)	(0.7,0.1,0.3)	(0.1,0.8,0.9)	(0.5,0.3,0.4)	(0.3,0.2,0.4)
$SVOA_6$	(0.6,0.2,0.4)	(0.6,0.2,0.4)	(0.6,0.2,0.4)	(0.1,0.8,0.9)	(0.5,0.3,0.4)	(0.6,0.2,0.4)	(0.1,0.8,0.9)	(0.9,0.2,0.1)
$SVOA_7$	(0.1,0.8,0.9)	(0.7,0.1,0.3)	(0.1,0.8,0.9)	(0.7,0.1,0.3)	(0.4,0.1,0.3)	(0.7,0.1,0.3)	(0.7,0.1,0.3)	(0.4,0.1,0.3)

$SVOA_8$	(0.7,0.1,0.3)	(0.7,0.1,0.3)	(0.7,0.1,0.3)	(0.3,0.2,0.4)	(0.4,0.1,0.3)	(0.7,0.1,0.3)	(0.3,0.2,0.4)	(0.3,0.2,0.4)
	$SVOC_1$	$SVOC_2$	$SVOC_3$	$SVOC_4$	$SVOC_5$	$SVOC_6$	$SVOC_7$	$SVOC_8$
$SVOA_1$	(0.5,0.3,0.4)	(0.7,0.1,0.3)	(0.4,0.1,0.3)	(0.6,0.2,0.4)	(0.3,0.2,0.4)	(0.9,0.2,0.1)	(0.1,0.8,0.9)	(0.4,0.1,0.3)
$SVOA_2$	(0.1,0.8,0.9)	(0.1,0.8,0.9)	(0.9,0.2,0.1)	(0.3,0.2,0.4)	(0.6,0.2,0.4)	(0.4,0.1,0.3)	(0.5,0.3,0.4)	(0.6,0.2,0.4)
$SVOA_3$	(0.9,0.2,0.1)	(0.5,0.3,0.4)	(0.6,0.2,0.4)	(0.3,0.2,0.4)	(0.9,0.2,0.1)	(0.7,0.1,0.3)	(0.1,0.8,0.9)	(0.3,0.2,0.4)
$SVOA_4$	(0.3,0.2,0.4)	(0.1,0.8,0.9)	(0.5,0.3,0.4)	(0.5,0.3,0.4)	(0.5,0.3,0.4)	(0.5,0.3,0.4)	(0.9,0.2,0.1)	(0.9,0.2,0.1)
$SVOA_5$	(0.6,0.2,0.4)	(0.9,0.2,0.1)	(0.1,0.8,0.9)	(0.5,0.3,0.4)	(0.1,0.8,0.9)	(0.5,0.3,0.4)	(0.3,0.2,0.4)	(0.1,0.8,0.9)
$SVOA_6$	(0.4,0.1,0.3)	(0.3,0.2,0.4)	(0.9,0.2,0.1)	(0.1,0.8,0.9)	(0.9,0.2,0.1)	(0.1,0.8,0.9)	(0.6,0.2,0.4)	(0.9,0.2,0.1)
$SVOA_7$	(0.5,0.3,0.4)	(0.5,0.3,0.4)	(0.5,0.3,0.4)	(0.5,0.3,0.4)	(0.7,0.1,0.3)	(0.5,0.3,0.4)	(0.7,0.1,0.3)	(0.5,0.3,0.4)
$SVOA_8$	(0.1,0.8,0.9)	(0.1,0.8,0.9)	(0.1,0.8,0.9)	(0.7,0.1,0.3)	(0.5,0.3,0.4)	(0.1,0.8,0.9)	(0.5,0.3,0.4)	(0.7,0.1,0.3)

We used the SVN gematric operator to combine the opinions of experts and decision makers such as:

$$P - SVNWG(S_1, S_2, \ldots, S_n) = SVOC_1$$

0.5346999160.2658506780.396927205

0.2750045620.495196590.648704759

0.7632463470.133397870.236753653

0.4517519420.2327767690.396927205

0.2656072510.4925663190.666128133

0.4196814020.1664350990.365455362

0.3593851510.5144410680.618328316

0.1944833170.6661281330.805516683

$SVOC_2 =$

0.7025011830.0990512560.297498817

0.1023292990.7967550820.897670701

0.434529930.1707558630.332341136

0.2554815810.451546320.630372133

0.6894136110.1982128580.310586389

0.3816716840.1982128580.396927205

0.3307824460.495196590.648704759

0.3307824460.495196590.648704759

$SVOC_3 =$

0.4036820060.0990512560.297498817

0.9009487440.1982128580.099051256

0.6030727950.1982128580.396927205

0.6286729990.1707558630.332341136

0.2554815810.451546320.630372133

0.6894136110.1982128580.310586389

0.3307824460.495196590.648704759

0.3307824460.495196590.648704759

$SVOC_4 =$

0.6030727950.1982128580.396927205

0.3816716840.1982128580.396927205

0.3338718670.1664350990.365455362

0.5626036640.2367536530.365455362

0.5626036640.2367536530.365455362

0.1470449160.6788562360.815162574

0.3307824460.495196590.648704759

0.4753269830.2023689040.365455362

$SVOC_5 =$

0.3036337490.1982128580.396927205

0.6030727950.1982128580.396927205

0.7881156810.1982128580.211884319

0.2750045620.495196590.648704759

0.3307824460.495196590.648704759

0.3593851510.5144410680.618328316

0.4415828160.133397870.332341136

0.4967407760.2023689040.365455362

$SVOC_6 =$

0.9009487440.1982128580.099051256

0.4036820060.0990512560.297498817

0.7025011830.0990512560.297498817

0.5034777750.2974988170.396927205

0.1740444190.692700290.815162574

0.3816716840.4925663190.618328316

0.5974923750.2023689040.365455362

0.307299710.451546320.630372133

$SVOC_7 =$

0.1023292990.7967550820.897670701

0.5346999160.2658506780.396927205

0.307299710.451546320.630372133

0.6345446380.133397870.236753653

0.4517519420.2327767690.396927205

0.2656072510.4925663190.666128133

0.3696278670.451546320.630372133

0.4253732910.2658506780.396927205

$SVOC_8 =$

0.4036820060.0990512560.297498817

0.6030727950.1982128580.396927205

0.3036337490.1982128580.396927205

0.9009487440.1982128580.099051256

0.1470449160.6788562360.815162574

0.9009487440.1982128580.099051256

0.5226635960.1707558630.332341136

0.279468180.4724548650.648704759

Then we use the SVN average operator to combine different criteria values in one as:

$$P - SVNWA(S_1, S_2, \dots, S_n) =$$

0.5681454720.1886328190.331661966

0.5479926180.2515596270.379026088

0.574408680.1841157330.340341368

0.5859464010.2525557340.341157652

0.389885870.3927168170.548185122

0.5217005970.3199524260.417689431

0.4189925810.326779570.505964436

0.3623839350.373583450.54109565

Then we apply the score function to obtain the final score. The alternatives are ranked as:

$$SVOA3 > SVOA1 > SVOA4 > SVOA2 > SVOA6 > SVOA7 > SVOA5 > SVOA8$$

5. Conclusions

A revolutionary strategy for promoting student preparedness and employability is the incorporation of AI assessment models into career planning courses at universities. According to this study, when compared to conventional pedagogies, AI-enhanced techniques, like virtual simulations, adaptive learning systems, and intelligent feedback tools, significantly increase teaching outcomes. The alternatives with the best efficacy scores were those that included tailored guiding mechanisms and real-time performance metrics. The Probabilistic Single-Valued Neutrosophic is used to solve uncertainty information. The Probabilistic Single-Valued Neutrosophic operator is used to combine the opinions of experts and decision makers. The report also emphasizes how important it is for colleges to embrace AI technology as key elements of their professional education strategies, rather than just as auxiliary tools. Institutions should make future investments in curriculum innovation, ongoing teacher training, and scalable AI infrastructure to guarantee inclusive and long-lasting career planning results.

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