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Method for evaluating the computer network security with uncertain linguistic information

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ABSTRACT

In order to effectively use information resources, information sharing and information to adapt to the requirements of rapid expansion, the establishment of internal computer networks and based on computer network management system is entered into the network economy era, is also the basic condition of the establishment of a modern management system technology base, but like unauthorized access, illegal operation, information leak and services such as refuse to issue of network security directly affect the computer network system of the normal application, therefore, network security design become network design is very important part. In this paper, we investigate the problems for evaluating the computer network security with uncertain linguistic variables. We utilize the uncertain linguistic correlate geometric mean (ULCGM) operator to aggregate the uncertain linguistic variables corresponding to each alternative and get the overall value of the alternatives, then rank the alternatives and select the most desirable one (s). Finally, an illustrative example demonstrates the practicality and effectiveness of the proposed method.

KEYWORDS

Computer technology; Uncertain linguistic information; Uncertain linguistic correlate geometric mean (ULCGM) operator; Computer network security.

INTRODUCTION

Since 2003, the financial securities industry on a large scale centralized computer network construction and the business process reorganization, has fully into the "data centralization" era, safety risk highlight, safety accident will lead to greater economic loss and reputation effect. Not only that, the computer network is malicious invasion, there are more and more opportunities, and difficult to avoid network own fault, face data loss, host is down machine, transmission interrupt, network paralysis caused by the business interruption, risk grows day by day. Therefore, the business process of the reliability and continuity put forward higher request. The traditional by the network anti-virus system, intrusion detection system, vulnerability scanning system composed of passive strategy to give priority to safety defense system, a threat feature code accumulation and depend on machine learning training to achieve the purpose of defense, not from the enterprise business process, operating system and host computer source strengthening protection, the defense system to enhance the ability of the business process security[1-9].

The aim of this paper is to investigate the problems for evaluating the computer network security with uncertain linguistic information. Then, we utilize the uncertain linguistic correlate geometric mean (ULCGM) operator to aggregate the uncertain linguistic variables corresponding to each alternative and get the overall value of the alternatives, then rank the alternatives and select the most desirable one (s). The remainder of this paper is set out as follows. In the next section, we introduce some basic concepts related to uncertain linguistic variables. In Section 3 we introduce the problem to evaluate the computer network security with uncertain linguistic information, in which the information about attribute weights is correlative, and the attribute values take the form of uncertain linguistic variables. Then, we utilize the uncertain linguistic correlate geometric mean (ULCGM) operator to aggregate the uncertain linguistic corresponding to each alternative and get the overall value of the alternatives, then rank the alternatives and select the most desirable one (s) by using the formula of the degree of possibility for the comparison between two uncertain linguistic variables. In Section 4, an illustrative example is pointed out. In Section 5 we conclude the paper and give some remarks.

PRELIMINARIES

Let $S=\{s_i \mid i=1,2,\cdots,t\}$ be a linguistic term set with odd cardinality. Any label, s_i represents a possible value for a linguistic variable, and it should satisfy the following characteristics[10]:①The set is ordered: $s_i > s_j$, if $i > j$;②There is the negation operator: $neg(s_i)=s_j$ such that $j=t+1-i$;③Max operator: $\max(s_i,s_j)=s_i$, if $s_i \ge s_j$;④Min operator: $\min(s_i,s_j)=s_i$, if $s_i \le s_j$. For example, S can be defined as

$$\begin{aligned} S=\{ & s_1=extremely\ poor, s_2=very\ poor, s_3=poor, s_4=medium, \\ & s_5=good, s_6=very\ good, s_7=extremely\ good\} \end{aligned}$$

Definition 1[11-12]. Let $\tilde{s}_1=[s_{\alpha_1},s_{\beta_1}]$ and $\tilde{s}_2=[s_{\alpha_2},s_{\beta_2}]$ be two uncertain linguistic variables, and let $len(\tilde{s}_1)=\beta_1-\alpha_1, len(\tilde{s}_2)=\beta_2-\alpha_2$, then the degree of possibility of $\tilde{s}_1 \ge \tilde{s}_2$ is defined as[16-19]

$$p(\tilde{s}_1 \ge \tilde{s}_2)=\frac{\max(0, len(\tilde{s}_1)+len(\tilde{s}_2)-\max(\beta_2-\alpha_1,0))}{len(\tilde{s}_1)+len(\tilde{s}_2)} \quad \textbf{(1)}$$

From Definition 1, we can easily get the following results easily:

(1) $0 \le p(\tilde{s}_1 \ge \tilde{s}_2) \le 1, 0 \le p(\tilde{s}_2 \ge \tilde{s}_1) \le 1$;

(2) $p(\tilde{s}_1 \ge \tilde{s}_2)+p(\tilde{s}_2 \ge \tilde{s}_1)=1$. Especially, $p(\tilde{s}_1 \ge \tilde{s}_1)=$ $p(\tilde{s}_2 \ge \tilde{s}_2)=0.5$.

In the following, Xu[13] shall propose an uncertain linguistic correlate geometric mean (ULCGM) operator.

Definition 2. Let $\tilde{s}_i=[s_{a_i},s_{b_i}](i=1,2,\cdots,n)$ be a collection of uncertain linguistic variables on $\tilde{S}$, and μ be a fuzzy measure on $\tilde{S}$, The (discrete) uncertain linguistic Choquet integral of $\tilde{s}_i$ with respect to μ is defined by

$$ULCGM\left(\tilde{s}_1,\tilde{s}_2,\cdots,\tilde{s}_n\right)$$
$$=\left(\tilde{s}_{\sigma(1)}\right)^{\left(\mu\left(A_{(1)}\right)-\mu\left(A_{(2)}\right)\right)}\otimes\left(\tilde{s}_{\sigma(2)}\right)^{\left(\mu\left(A_{(2)}\right)-\mu\left(A_{(3)}\right)\right)}\otimes\cdots\otimes\left(\tilde{s}_{\sigma(n)}\right)^{\left(\mu\left(A_{(n)}\right)-\mu\left(A_{(n+1)}\right)\right)} \quad \textbf{(2)}$$
$$=\bigotimes_{i=1}^{n}\left(\tilde{s}_{\sigma(i)}\right)^{\left(\mu\left(A_{(i)}\right)-\mu\left(A_{(i+1)}\right)\right)}$$

where $\left(\sigma(1),\sigma(2),\cdots,\sigma(n)\right)$ is a permutation of $\left(1,2,\cdots,n\right)$, such that $\tilde{s}_{\sigma(j-1)}\leq\tilde{s}_{\sigma(j)}$ for all $j=2,\cdots,n$, $A_{(i)}=\left((i),\cdots,(n)\right)$, $A_{(n+1)}=\phi$.

METHOD FOR EVALUATING THE COMPUTER NETWORK SECURITY WITH UNCERTAIN LINGUISTIC INFORMATION

The following assumptions or notations are used to represent the problems for evaluating the computer network security with uncertain linguistic variables. Let $A=\left\{A_1,A_2,\cdots,A_m\right\}$ be a discrete set of alternatives. Let $G=\left\{G_1,G_2,\cdots,G_n\right\}$ be a set of attributes. The information about attribute weights is completely known. Let $\omega=\left(\omega_1,\omega_2,\cdots,\omega_n\right)$ be the weight vector of attributes, where $\omega_j\geq 0$, $j=1,2,\cdots,n$. Suppose that $\tilde{R}=\left(\tilde{r}_{ij}\right)_{m\times n}$ is decision matrix, where $\tilde{r}_{ij}\in\tilde{S}$ is a preference value, which take the form of uncertain linguistic variable, given by the decision maker for the alternative $A_i\in A$ with respect to the attribute $G_j\in G$.

In the following, we apply the ULCGM operator for evaluating the computer network security with uncertain linguistic variables.

Step 1. Determine the fuzzy measure of attribute of $G_j\left(j=1,2,\cdots,n\right)$ and attribute sets of G. There are a few methods for the determination of the fuzzy measure. For example, linear methods, quadratic methods, heuristic-based methods and genetic algorithms and so on are available in the literature.

Step 2. Utilize the ULCGM operator

$$\tilde{r}_i=\text{ULCGM}\left(\tilde{r}_{i1},\tilde{r}_{i2},\cdots,\tilde{r}_{in}\right)$$
$$=\left(\tilde{r}_{\sigma(i1)}\right)^{\left(\mu\left(A_{(1)}\right)-\mu\left(A_{(2)}\right)\right)}\otimes\left(\tilde{r}_{\sigma(i2)}\right)^{\left(\mu\left(A_{(2)}\right)-\mu\left(A_{(3)}\right)\right)}\otimes\cdots\otimes\left(\tilde{r}_{\sigma(in)}\right)^{\left(\mu\left(A_{(n)}\right)-\mu\left(A_{(n+1)}\right)\right)} \quad \textbf{(3)}$$
$$=\bigotimes_{j=1}^{n}\left(\tilde{r}_{\sigma(ij)}\right)^{\left(\mu\left(A_{(j)}\right)-\mu\left(A_{(j+1)}\right)\right)}$$

to derive the overall preference values $\tilde{r}_i\left(i=1,2,\cdots,m\right)$ of the alternative A_i.

Step 3. To rank these collective overall preference values $\tilde{r}_i\left(i=1,2,\cdots,m\right)$, we first compare each $\tilde{r}_i$ with all the $\tilde{r}_j\left(j=1,2,\cdots,m\right)$ by using Eq. (2). For simplicity, we let $p_{ij}=p\left(\tilde{r}_i\geq\tilde{r}_j\right)$, then we develop a complementary matrix as $P=\left(p_{ij}\right)_{m\times m}$, where $p_{ij}\geq 0$, $p_{ij}+p_{ji}=1$, $p_{ii}=0.5$, $i,j=1,2,\cdots,n$.

Summing all the elements in each line of matrix P, we have

$$p_i=\sum_{j=1}^{m}p_{ij},i=1,2,\cdots,m.$$

Then we rank the collective overall preference values $\tilde{r}_i\left(i=1,2,\cdots,m\right)$ in descending order in accordance with the values of $p_i\left(i=1,2,\cdots,m\right)$.

Step 4. Rank all the alternatives $A_i\left(i=1,2,\cdots,m\right)$ and select the best one (s) in accordance with the collective overall preference values $\tilde{r}_i\left(i=1,2,\cdots,m\right)$.

Step 5. End.

NUMERICAL EXAMPLE

The proliferation of today's networks mainly is due to the system integration of the fields of communications, network, automation, and control. The computer network has grown from a simple time-sharing system-a number of terminals connected to a central computer-to a large, complex environment that provides infrastructures to many critical and economically valuable components of economies. The military started out with the idea of securing each individual computer and later expanded the concept to securing a network of computers and devices. However, it is not the only organization that requires and has implemented some form of network security. Network security has evolved over the years and also in other departments of government and government networks. Therefore, the issues of network security have been of great concern in each country and especially in military requirements. This section presents a numerical example to evaluate the computer network security with uncertain linguistic information to illustrate the method proposed in this paper. There are five possible computer network systems $A_i\left(i=1,2,3,4,5\right)$ for four attributes $G_j\left(j=1,2,3,4\right)$. The four attributes include the tactics $\left(G_1\right)$, technology and economy $\left(G_2\right)$, logistics $\left(G_3\right)$ and strategy $\left(G_4\right)$, respectively. The five possible computer network systems $A_i\left(i=1,2,\cdots,5\right)$ are to be evaluated using the linguistic term set S

$$\begin{aligned}S=\{&s_1=extremely\ poor, s_2=very\ poor, s_3=poor, s_4=medium,\\ &s_5=good, s_6=very\ good, s_7=extremely\ good\}\end{aligned}$$

by the decision maker under the above four attributes, as listed in the following matrix.

$$\tilde{R}=\begin{array}{c} \\ A_1\\ A_2\\ A_3\\ A_4\\ A_5\end{array}\begin{array}{c}\begin{array}{cccc}G_1 & G_2 & G_3 & G_4\end{array}\\ \left(\begin{array}{cccc}[s_5,s_6] & [s_4,s_6] & [s_4,s_5] & [s_4,s_6]\\ [s_4,s_5] & [s_3,s_4] & [s_3,s_4] & [s_3,s_4]\\ [s_2,s_3] & [s_4,s_5] & [s_4,s_5] & [s_4,s_5]\\ [s_1,s_2] & [s_4,s_6] & [s_2,s_3] & [s_5,s_6]\\ [s_3,s_4] & [s_5,s_6] & [s_5,s_6] & [s_4,s_6]\end{array}\right)\end{array}$$

Then, we utilize the uncertain linguistic approach developed to get the most desirable computer network systems.

Step 1. Suppose the fuzzy measure of attribute of $G_j\left(j=1,2,\cdots,n\right)$ and attribute sets of G as follows:

$$\begin{aligned}&\mu\left(G_1\right)=0.25, \mu\left(G_2\right)=0.35, \mu\left(G_3\right)=0.30, \mu\left(G_4\right)=0.20\\ &\mu\left(G_1,G_2\right)=0.70, \mu\left(G_1,G_3\right)=0.75, \mu\left(G_1,G_4\right)=0.60\\ &\mu\left(G_2,G_3\right)=0.70, \mu\left(G_2,G_4\right)=0.65, \mu\left(G_3,G_4\right)=0.65\\ &\mu\left(G_1,G_2,G_3\right)=0.75, \mu\left(G_1,G_2,G_4\right)=0.80\\ &\mu\left(G_1,G_3,G_4\right)=0.80, \mu\left(G_2,G_3,G_4\right)=0.75\\ &\mu\left(G_1,G_2,G_3,G_4\right)=1.00\end{aligned}$$

Step 2. Utilize the decision information given in matrix $\tilde{R}$, and the ULCG operator, we obtain the overall preference values $\tilde{r}_i$ of the computer network systems $A_i\left(i=1,2,\cdots,5\right)$.

$$\begin{aligned}&\tilde{r}_1=\left[s_{2.34}, s_{3.56}\right], \tilde{r}_2=\left[s_{2.53}, s_{3.78}\right], \tilde{r}_3=\left[s_{1.49}, s_{3.70}\right]\\ &\tilde{r}_4=\left[s_{2.23}, s_{3.48}\right], \tilde{r}_5=\left[s_{2.49}, s_{4.23}\right]\end{aligned}$$

Step 3. Rank these preference degree $\tilde{r}_i\left(i=1,2,3,4,5\right)$, we first compare each $\tilde{r}_i$ with all the $\tilde{r}_j\left(j=1,2,3,4,5\right)$ by using Eq. (1), and then develop a complementary matrix:

$$P=\begin{bmatrix} 0.500 & 1.000 & 1.000 & 1.000 & 0.100 \\ 0.000 & 0.500 & 0.225 & 0.134 & 0.677 \\ 0.000 & 0.775 & 0.500 & 0.312 & 0.855 \\ 0.000 & 0.866 & 0.688 & 0.500 & 0.875 \\ 0.900 & 0.323 & 0.145 & 0.125 & 0.500 \end{bmatrix}$$

Summing all the elements in each line of matrix P, we have

$$p_1=0.534,\ p_2=2.348,\ p_3=3.023,\ p_4=3.867,\ p_5=2.389.$$

Then we rank the preference degree $\tilde{r}_i\left(i=1,2,3,4,5\right)$ in descending order in accordance with the values of $p_i\left(i=1,2,\cdots,5\right)$: $\tilde{r}_4 \succ \tilde{r}_3 \succ \tilde{r}_5 \succ \tilde{r}_2 \succ \tilde{r}_1$.

Step 4. Rank all the computer network systems $A_i\left(i=1,2,\cdots,5\right)$ in accordance with the preference degree $\tilde{r}_i\left(i=1,2,\cdots,5\right)$: $A_4 \succ A_3 \succ A_5 \succ A_2 \succ A_1$, and thus the most desirable computer network system is A_4.

CONCLUSION

In this paper, we investigate the problems for evaluating the computer network security with uncertain linguistic variables. We utilize the uncertain linguistic correlate geometric mean (ULCGM) operator to aggregate the uncertain linguistic variables corresponding to each alternative and get the overall value of the alternatives, then rank the alternatives and select the most desirable one (s). Finally, an illustrative example demonstrates the practicality and effectiveness of the proposed method.

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REFERENCES

[1] B.B.Madan, G.P.Katerma, K.Vaidyanathan, K.S.Trivedi; A method for modeling and quantifying the security attributes of intrusion tolerant system, Performance Evaluation, **118(3)**, 429-436 **(2001)**.

[2] P.T.Chang, K.C.Hung; Applying the fuzzy-weighted-average approach to evaluate network security systems, Computers and Mathematics with Applications, **49(5)**, 1797-1814 **(2005)**.

[3] Xiaopeng Jian, Yanfang Li, zhengqiang Jiang, Lite Li; "An Approach to Evaluating the Construction Projects of Wastewater Treatment in the Paper Making Factory with Uncertain Linguistic Variables", International Journal of Digital Content Technology and its Applications, **6(4)**, 95-101 **(2012)**.

[4] Xuehua Liu; "Research on the Competitiveness of China's Tourism Trade in Service with Uncertain Linguistic Information", International Journal of Digital Content Technology and its Applications, **6(4)**, 214-220 **(2012)**.

[5] Chunying Long; "Research on the Garden Plant Landscape Evaluation with Linguistic Information", Advances in Information Sciences and Service Sciences, **4(5)**, 262-267 **(2012)**.

[6] Tiejun Wang; "Research on Evaluating Theory and Application to Design of Mechanical Products with Uncertain Linguistic Information", Advances in Information Sciences and Service Sciences, **4(5)**, 337-343 **(2012)**.

[7] Hanyan Huang; "Study on Comprehensive Assessment Model of Enterprise Management Information System with Uncertain Linguistic Variables", International Journal of Advancements in Computing Technology, **4(5)**, 207-213 **(2012)**.

[8] Yan Yi; "Research on the Software Quality Evaluation Based on Intelligent Computation with Linguistic Information", International Journal of Advancements in Computing Technology, **4(5)**, 249-255 **(2012)**.

[9] Guiwu Wei; "GRA method for multiple attribute decision making with incomplete weight information in intuitionistic fuzzy setting", Knowledge-Based Systems, **23(3)**, 243-247 **(2010)**.
[10] F.Herrera, L.Nartinez; "A 2-tuple fuzzy linguistic representation model for computing with words", IEEE Transactions on Fuzzy Systems, **8(6)**, 746-752 **(2000)**.
[11] Zeshui Xu; "Uncertain linguistic aggregation operators based approach to multiple attribute group decision making under uncertain linguistic environment", Information Science, **168(3)**, 171-184 **(2004)**.
[12] Guiwu Wei; "Uncertain linguistic hybrid geometric mean operator and its Application to group decision making under uncertain linguistic environment", International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems, **17(2)**, 251-267 **(2009)**.
[13] Zeshui Xu; "Correlated linguistic information aggregation", International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems, **17(5)**, 633-647 **(2009)**.