

Network Security Assessment Model of Coupling Empowerment

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Abstract. By means of accelerating the fuzzy Analytic Hierarchy Process(AHP) screening index of genetic algorithm, this paper constructs evaluation index system of computer network security, puts forward the information entropy with objective and subjective empowerment and improved AHP coupling weighting, sequences the influence factors of network security, the network safety evaluation model is established with the fuzzy comprehensive evaluation method. Application results show that the evaluate results of this model are objective and reasonable.

Introduction

Along with the rapid development of information technology in various fields of economic and social, hackers, computer viruses continuous generation and dissemination, have resulted in significant economic losses to individuals, businesses and countries. How to build a scientific and rational evaluation of network security system, a comprehensive, objective, scientific evaluation of network security situation, is the focus of the protection of information security. Entropy is the important tools of information theory to describe the uncertainty of the information and the random variable, the law of entropy weight is an objective weighting method, its principle is based on the degree of variability of evaluation values reflected in the size of the amount of information to determine the weight of . In this paper, based on a combination of objective and subjective weighting improved Analytic Hierarchy Process (Analytic Hierarchy Process, AHP) with information entropy coupling weighting method to establish a computer network security evaluation model.

The establishment of the network security evaluation model

Set the index system of evaluation elements.

In this paper, based on accelerating genetic algorithm fuzzy Analytic Hierarchy Process (Accelerating Genetic Algorithm Fuzzy AHP, AGA-FAHP) screening, the establishment of evaluation index. The specific approach: ask the experts on the evaluation of the importance of the two indicators for comparison, the establishment of fuzzy complementary judgment matrix $P = (p_{ij})$,

requiring $0 \leq p_{ij} \leq 1, p_{ij} + p_{ji} = 1$ (shows the extent i better than j). If P does not have a satisfactory consistency, you need to fix. N bits can ask experts to independently establish N rights fuzzy complementary judgment matrix P, N group AGA-FAHP solution evaluation in order to improve the reliability of the indicators screening $w_{k,j} (j = 1, 2, \dots, M; k = 1, 2, \dots, N)$, the average weight of elected

evaluation is $\bar{w}_j = \sum_{k=1}^N w_{k,j} / N$, the largest m indicators composed the ultimate computer network security evaluation index system $x_i (i = 1, 2, \dots, m)$. The evaluation index system obtained by the above screening computer network security is shown in Table 1.

Table 1. Computer network security evaluation index system

Primary indicators	Secondary indicators
Physical security B ₁	Line safety C ₁₁ , physical equipment safety C ₁₂ , environmental safety C ₁₃
Management security B ₂	Organization system C ₂₁ , system construction C ₂₂ , safety training plan C ₂₃
Software security B ₃	Operating system security C ₃₁ , application software security C ₃₂ , antivirus software C ₃₃
Hardware security B ₄	Firewal C ₄₁ , intrusion detection system C ₄₂
Data security B ₅	Data backup C ₅₁ , access control C ₅₂ , Identity C ₅₃ , data encryption C ₅₄

The determination of comment set.

According to the actual needs of the evaluation decision, determine the comment set: $V = \{very\ safe, safe, safer, basic\ safe, unsafe\}$. Assignment to the comment set is $V = \{95, 85, 75, 65, 55\}$.

The determination of entropy and the improved coupling weight of AHP.

Supposing there is m evaluation index, n evaluation object, the form of the original data matrix is $X = (x_{ij})_{m \times n}$. Entropy weight calculation steps are: (1) Normalization processing the X' index value, get matrix $X = (x_{ij})_{m \times n}$.

$$p_{ij} = x_{ij} / \sum_{j=1}^n x_{ij}$$

(2) Calculated j-th evaluation indicator weight under i-th indicator

$$e_i = -k \sum_{j=1}^n p_{ij} \ln p_{ij}, k = \frac{1}{\ln n}$$

i-th indicator entropy:

(3) Calculated

$$w_i = W_i w_i / \sum_{i=1}^m W_i w_i$$

empower:

Coupling weights corrected each evaluation, at the ultimate computer network security evaluation index system indicators.

Fuzzy Comprehensive Evaluation.

Evaluating each single factor indicators by the evaluation experts (n persons), we can get the single

factor membership $(n_1/n, n_2/n, n_3/n, n_4/n, n_5/n)$, $n = \sum_{i=1}^5 n_i$. So, we can get $C_i (i=1, 2, 3, 4, 5)$. Then, according to the multistage comprehensive evaluation method is obtained in each subset evaluation decision matrix, and finally get the computer network security evaluation result.

An application example

The determination of index weight at all levels.

We take the three secondary indicators C₁₁, C₁₂ and C₁₃ of the primary indicators B₁ as example.

(1) Inviting experts make comparison of the three factors of two importance, building the complementary judgement matrix F_{C1}, and turning it into fuzzy consistent matrix F'_{C1}, i.e:

$$F_{C_1} = \begin{pmatrix} 0.5 & 1 & 0 \\ 0 & 0.5 & 0 \\ 1 & 1 & 0.5 \end{pmatrix}, F'_{C_1} = \begin{pmatrix} 0.5 & 0.67 & 0.33 \\ 0.5 & 0.5 & 0.17 \\ 0.67 & 0.83 & 0.5 \end{pmatrix}, w_{C_1} = (0.333, 0.213, 0.454)$$

(2) To the physical security three evaluation index, invited 10 experts on each index of the important degree to grade raw data matrix:

$$X_{C_1} = \begin{pmatrix} 0.6 & 0.3 & 0.1 \\ 0.5 & 0.3 & 0.2 \\ 0.4 & 0.4 & 0.2 \end{pmatrix}, \text{normalized: } X'_{C_1} = \begin{pmatrix} 1 & 0.4 & 0 \\ 1 & 0.33 & 0 \\ 1 & 1 & 0 \end{pmatrix}, \text{entropy weight: } w_{C_1} = (0.277, 0.298, 0.225)$$

(3) Using $w_i = W_i w_i / \sum_{i=1}^m W_i w_i$ on the three evaluation index for correction, get coupling weight vector $\omega_{c_1} = (0.358, 0.246, 0.396)$. Similarly for the others each layer index of the coupling weight, the results such as shown in Table 2.

Table 2. A computer network security evaluation index weight and sort the coupling

Primary indicators	Primary indicators weight	Secondary indicators	Secondary indicators weight	Combination weight	Weight sorting
Physical security B ₁	0.120	C ₁₁	0.358	0.043	10
		C ₁₂	0.246	0.030	12
		C ₁₃	0.396	0.048	8
Management security B ₂	0.097	C ₂₁	0.458	0.044	9
		C ₂₂	0.413	0.040	11
		C ₂₃	0.129	0.013	15
Software security B ₃	0.217	C ₃₁	0.422	0.092	3
		C ₃₂	0.278	0.060	7
		C ₃₃	0.300	0.065	6
Hardware security B ₄	0.353	C ₄₁	0.603	0.213	1
		C ₄₂	0.397	0.140	2
Data security B ₅	0.213	C ₅₁ ,	0.370	0.079	4
		C ₅₂	0.362	0.077	5
		C ₅₃	0.128	0.027	14
		C ₅₄	0.140	0.030	13

The implementation of the comprehensive evaluation.

In order to evaluate the safety of the network, we organize the related experts on the secondary index according to the comments concentration of 5 levels to a vote, the normalized results such as shown in Table 3.

Table 3. Experts vote normalization results of a computer network security evaluation secondary indicators

Secondary indicators	Very safe	Safe	Safer	Basically safe	Unsafe
C ₁₁	0.4	0.30	0.25	0.05	0.05
C ₁₂	0.2	0.40	0.30	0.10	0.00
C ₁₃	0.4	0.25	0.20	0.10	0.05
C ₂₁	0.4	0.30	0.20	0.10	0.00
C ₂₂	0.2	0.30	0.30	0.10	0.00
C ₂₃	0.1	0.40	0.30	0.10	0.10
C ₃₁	0.5	0.30	0.10	0.10	0.00
C ₃₂	0.4	0.50	0.20	0.00	0.00
C ₃₃	0.3	0.30	0.35	0.10	0.00
C ₄₁	0.3	0.40	0.25	0.05	0.05
C ₄₂	0.3	0.40	0.20	0.10	0.00
C ₅₁	0.3	0.30	0.30	0.10	0.00
C ₅₂	0.2	0.30	0.30	0.10	0.00
C ₅₃	0.1	0.40	0.30	0.10	0.10
C ₅₄	0.3	0.30	0.20	0.10	0.10

So, the first indicators physical security weight vector is:

$$W_{B_1} = W_{C_1} \cdot R_1 = (0.358, 0.246, 0.396) \begin{pmatrix} 0.4 & 0.3 & 0.25 & 0.05 & 0.05 \\ 0.2 & 0.4 & 0.3 & 0.1 & 0 \\ 0.4 & 0.25 & 0.2 & 0.1 & 0.05 \end{pmatrix} = (0.396, 0.3, 0.25, 0.1, 0.05)$$

Through normalization: $\bar{W}_{B_1} = (0.36, 0.27, 0.23, 0.09, 0.05)$. Similarly,

$$\bar{W}_{B_2} = (0.33, 0.25, 0.25, 0.08, 0.08), \bar{W}_{B_3} = (0.36, 0.27, 0.27, 0.09, 0)$$

$$\bar{W}_{B_4} = (0.27, 0.36, 0.23, 0.09, 0.05), \bar{W}_{B_5} = (0.27, 0.27, 0.27, 0.1, 0.08)$$

So as to get the computer network security evaluation results of A weight vector:

$$W_A = W_B \cdot R_B = W_B \cdot (\overline{W}_{B_1}, \overline{W}_{B_2}, \overline{W}_{B_3}, \overline{W}_{B_4}, \overline{W}_{B_5})^T = (0.27, 0.353, 0.23, 0.1, 0.08)$$

Through normalization: $\overline{W}_A = (0.261, 0.342, 0.223, 0.097, 0.077)$. Because of $Z = W_A \cdot W^T$, the network security status for the comprehensive evaluation score is $Z = 81.1$.

Analysis of the results.

Through the calculation above, using the fuzzy comprehensive evaluation method is concluded that the network security evaluation results show that 26.1% very safe, 34.2% for security, 22.3% for a safer, 9.7% for the basic safety, 7.7% for safety. According to the principle of maximum membership, the network security rating for the "safe" level, the comprehensive score of 81.1, security is good, the results basically in accord with actual situation.

Table 2 calculation results can be seen: among the influence network security primary factor, hardware safe impact, accounting for 35.3%; In the secondary factor in primary factor influence, environmental safety, organization system, operating system security, firewall and data backup to the corresponding level factor influences, respectively is 62.5%, 45.8%, 42.2%, 60.3% and 37.0%; In the secondary factor in computer network security in the overall effect, firewall and intrusion detection system for network security influence row in 15 index the first position, the second, specific gravity are 21.3% and 14.0% respectively, therefore, in the network security, it shall pay special attention to hardware security on the influence of computer network security.

Conclusions

Influence factors of computer network security has multi-level and multi-attribute characteristic, for this reason, this paper puts forward a kind of based on improved AHP and information entropy coupling empowerment computer network security evaluation model. The numerical example shows that, this model can for the network system security strategy and security solutions offer establish the basis, so as to guide the network information system security system and the construction of the management system. Due to the different assessment method to analyze the problem from different angles, and the result also unavoidably exists deficiencies, so to all kinds of evaluation method in combination, innovation, the comparison is the next research direction.

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