Selection of Alternatives about Safety of Wireless Sensor Network Based on Evidential Reasoning Algorithm

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Abstract

In general, wireless sensor network is composed of low-cost, low-power tiny nodes which could detect physical phenomena and communicate with each other to send sensor data to base station. As technology develops rapidly, wireless sensor network has been widely applied in many practical fields such as agriculture, structure monitoring, gas detection, medical treatments, health monitoring, military, E-commerce and so on. Although wireless sensor networks are beneficial for our life and society, it brought some problems. For example, when information of consumers leaks in a wireless sensor network, it may bring bad influence for these consumers or enterprises. Security is an important factor when we apply wireless sensor networks into many domains. How to select an appropriate alternative from some wireless sensor networks from the perspective of security of wireless sensor networks has attracted much attention from many researchers. In this paper, we invite many experts to help us solve this problem which could be considered as a group decision making problem. In order to handle this group decision making problem, a popular method called evidential reasoning algorithm is introduced to construct decision matrix, combine decision information and generate a solution. Finally, an application is demonstrated to verify the validity of the proposed algorithm and obtain an appropriate solution of this problem.

Keywords: wireless sensor network, security problem, group decision making, experts, evidential reasoning algorithm.

1. INTRODUCTION

Wireless sensor network is composed of large amount of tiny sensor nodes which can supervise the environment, acquire sensor data and transmit sensor data to the monitoring center through multi-hop routing (Teng, 2012). Wireless sensor networks is considered as a rapidly developed technological platform with many practical applications in some fields such as agriculture, structure monitoring, health monitoring, military, E-commerce and so on. There are some characteristic of wireless sensor networks including self-organizing nature, limited bandwidth and distributed operations. A routing protocol is a key point in sensor nodes of wireless sensor networks, especially when sensor data needs to be sent to base station (Shokouhifar and Jalali, 2017; Chanak et al., 2017). In this process, many security problems may exist and result in bad influence. Thus, security is an important factor when a wireless sensor networks could be adopted. If information in wireless sensor network leaks, the result may be serious especially in the fields of military and E-commerce. The result may influence the security of our country or consumers (Heizelman et al., 2002; De and Qiao, 2007; Finogeev and Finogeev, 2017). Many security solutions are proposed by researchers such as key exchange, secure routing, and authentication and security mechanisms and so on. Chen summarized the existing algorithms related to security of wireless sensor networks (Chen, 2012). In order to improve security mechanism of wireless sensor networks, Ruan considered designing an effective key management protocol for sensor network is very important (Ruan, 2009). In this paper, we focus on the selection of an appropriate alternative from the perspectives of security of wireless sensor networks based on several attributes. Many experts are invited in this selection problem. So, group decision making method is introduced in this paper.

Group decision making problems can be considered as decision situations where many decision makers express their preferences on the attributes of specific problems and try to obtain an appropriate result from several alternatives (Liao et al, 2015; Alonso et al., 2009; Bordogna et al., 1997). Group decision making and its related methods have attracted much attention of many researchers and practitioners. They may be from many practical fields such as engineering, economic, operations, business and management. Sometime the group decision making
is very simple sometimes it is complicated and uncertain. In this paper, we focus the last situation. Over the past two decades, considerable research as a hot point is operated on some techniques including artificial intelligence and operational research for addressing uncertain situations (Roberts and Goodwin, 2002; Yang and Du, 2002). Based on this idea, evidential reasoning methods have been proposed for group decision making under uncertain environment. In the beginning, this method is developed on the basis of an evaluation decision analysis model and the Dempster-Shafer (D-S) theory of evidence. After then, Yang et al proposed evidential reasoning algorithm and applied it to decision problems in information security assessment, engineering design, organization performance assessment and consumer selection. Evidential reasoning algorithm is simply called ER algorithm and is developed based on information combination algorithm of the Dempster-Shafer theory (Xu, 2009). The advantages of evidential reasoning algorithm can be concluded including the following aspects: (1) it can portray information of decision makers with flexibility to combine assessment information that are appropriate to the specific problems. (2) It could permit all feasible assessment information to be recorded in different formats, which includes qualitative and incomplete data in the assessment and analysis processes, which may result in more reliable and available solutions. (3) It could permit the assessment results to be expressed more informatively and transparently, which could help the effective communication and analysis of the results.

The construction of this paper is organized as follows. Section 2 constructs a new decision model and method which includes the basic concepts of ER algorithm, the determination of attribute weights, the aggregation of group assessment, the generation of an appropriate solution and the procedure of the developed method. An application of the evidential reasoning method in the selection of an appropriate alternative from the perspectives of security is operated in Section 4 and the proposed method is verified its validity. Section 5 concludes this paper.

2. THE EVIDENTIAL REASONING ALGORITHM FOR GROUP DECISION MAKING

In this section, the proposed method will be demonstrated including the modeling of a multiple attribute group decision making, determining weights of these multiple attributes, aggregation of group assessments and so on. These are considered as the first step for a selection problem of alternatives related to security problem of wireless sensor network.

2.1 The basic concepts of ER algorithm

Suppose that there are m alternatives in a multiple attribute decision making problem denoted by \( A_p \) \((p = 1, \ldots, m)\) and each assessment is evaluated on n attributes denoted by \( e_i \) \((i = 1, \ldots, q)\) by T experts denoted by \( t_j \) \((j = 1, \ldots, T)\). The weights of the n attributes are signified by \( w = (w_1, w_2, \ldots, w_n) \) in which \( 0 \leq w_i \leq 1 \) for \( i = 1, \ldots, q \) and \( \sum_{i=1}^{q} w_i = 1 \) which will be demonstrated in subsection 3.

Suppose N evaluation grades are developed that could provide a complete assessment set for evaluating some attributes, as demonstrated by \( \Omega = \{G_1, G_2, \ldots, G_N\} \) where \( G_n \) is the n\(^{th}\) evaluation grade. In general, we often assume that \( G_{n+1} \) is considered to be preferred to \( H_n \). An assessment for attribute \( e_i \) \((i = 1, \ldots, q)\) of an alternative may be denoted by using the following distribution:

\[
S(e_i) = \{(G_n, \gamma_{n,i}), n = 1, \ldots, N\},
\]

\[
i = 1, \ldots, q
\]

Where \( \gamma_{n,i} \geq 0, \sum_{n=1}^{N} \gamma_{n,i} \leq 1, \) and \( \gamma_{n,i} \) represents a degree of belief. The mentioned distributed assessment indicates that attribute \( e_i \) is evaluated to the grade \( H_n \) with the degree of belief of \( \gamma_{n,i}, n = 1, \ldots, N \). An assessment \( S(e_i) \) is considered to be complete if \( \sum_{n=1}^{N} \gamma_{n,i} = 1 \) and may be incomplete if \( \sum_{n=1}^{N} \gamma_{n,i} < 1 \). A special situation is \( \sum_{n=1}^{N} \gamma_{n,i} = 0 \) which may denote a complete ignorance which means the lack of information on the specific attribute \( e_i \). This partial or complete ignorance is often not rare in many real decision making problems.

2.2 The determination of attribute weights

Weight which is assigned to each of the basic attribute could reflect its relative importance to a specific assessment objective. Therefore, weights could be normalized in this situation. In general, the weights can be obtained by using the work experience, professional knowledge, and idea of a decision maker related to the problems. Some typical methods include direct rating, eigenvector method, linear programming algorithm, goal programming algorithm with pairwise comparison and so on. In the ER algorithm, weights are normalized by the following equation:

\[
\text{EVA}_i = \frac{w_i}{\sum_{j=1}^{n} w_j}
\]
The assessment of security of wireless sensor networks

The assessment of security of wireless sensor networks

Figure 1. The attribute system

2.3 The aggregation of group assessments

The evidential reasoning algorithm is based on probability masses which consider the relative importance of attributes.

Let $\delta_{n,i}$ be a basic function which means probability mass denoting the degree to which the $i^{th}$ given attribute accepts the hypothesis where the assessment objective is evaluated to the $n^{th}$ grade $G_n$. The probability mass $m_{n,i}$ is proposed as the weighted belief degree in the following.

$$\delta_{n,i} = w_i \cdot \delta_{a,i}$$

$$n = 1, ..., N$$

After all $\delta_{n,i}$ (n = 1, ..., N) have been evaluated, suppose $\delta_{H,i}$ is a remaining probability mass which does not be assigned to any given grades as follows.

$$\delta_{H,i} = 1 - \frac{1}{N} \sum_{n=1}^{N} \delta_{a,i} = 1 - w_i \sum_{n=1}^{N} \delta_{a,i}$$

$$n = 1, ..., N$$

If $\delta_{H,i}$ could divided into two parts: $\delta_{H,i}$ and $\delta_{H,i}'$, with $\delta_{H,i} = \delta_{H,i}' + \delta_{H,i}''$, in which

$$\delta_{H,i}' = 1 - w_i$$

$$\delta_{H,i}'' = w_i (1 - \frac{1}{N} \sum_{n=1}^{N} \gamma_{a,i})$$

Here, $\delta_{H,i}$ is denoted as the remaining probability mass that is considered as not be assigned to any individual grade. The reason why this thing happens is that attribute $i$ only plays one role in the evaluation as denoted by its weight. Here, $\delta_{H,i}$ is related to $w_i$ and will lead to the subsequent assessment to be incomplete.

From the existing studies, it can be deduced that the aggregated belief degrees of $\gamma_n$ and $\gamma_H$ can be generated by the following.
\[ \gamma_n = \frac{\prod_{i=1}^{n}(1-w_i) \sum_{j,k} y_{p_{ij}} - \prod_{i=1}^{n}(1-w_i) \sum p_{ij} y_{p_{ij}}}{\prod_{i=1}^{n}(1-w_i) \sum_{j,k} y_{p_{ij}} - (N-1) \prod_{i=1}^{n}(1-w_i) \sum p_{ij} y_{p_{ij}} - \prod_{i=1}^{n}(1-w_i)} \] 
\[ \beta_H = \frac{\prod_{i=1}^{n}(1-w_i) \sum_{j,k} y_{p_{ij}} - \prod_{i=1}^{n}(1-w_i)}{\prod_{i=1}^{n}(1-w_i) \sum_{j,k} y_{p_{ij}} - (N-1) \prod_{i=1}^{n}(1-w_i) \sum p_{ij} y_{p_{ij}} - \prod_{i=1}^{n}(1-w_i)} \] 

2.4 The generation of solution

After aggregation of assessments using ER algorithm, the collective result of each alternative is denoted by belief degrees which may not be directly compared with each other. In this case, it is necessary to develop numerical values which can be considered as the same as the belief degree. Then, the expected utility is introduced and applied to compare different belief structures.

Let \( u(G_n) \) be the utility value of the given grade \( G_n \) related to the situation of \( u(G_{n+1}) > u(G_n) \). Without loss of generality, the assessments are considered as incomplete, which means that \( \gamma_H \neq 0 \). \( \gamma_H \) is considered as the belief degree denoting the extent of incompleteness or ignorance in the decision assessment information and interval \([\gamma_n, \gamma_n + \gamma_H]\) could give the range of the belief degrees related to \( H_n \). In this circumstance, the minimum, the maximum and the average utilities are defined to characterize a belief structure as follows.

\[ u_x = \sum_{n=1}^{N} \gamma_n u(G_n) + (\gamma_n + \gamma_H) u(G_N) \] 
\[ u_a = \sum_{n=2}^{N} \gamma_n u(G_n) + (\gamma_1 + \gamma_H) u(G_1) \] 
\[ u_a = \frac{u_x + u_a}{2} \]

Here, \( u_x, u_a \) and \( u_a \) mean that the biggest, smallest and average values related to utility respectively could be generated.

2.5 The procedure of proposed method

The procedure of the GDM is proposed based on the mentioned methods, which is stated step by step as follows:

Step 1. Construct a multiple attribute group decision making problem. A manager or a decision maker selects \( T \) experts, identifies \( q \) attributes and \( N \) grades, and lists \( m \) alternatives to form an evaluated problem.

Step 2. Collect the decision makers’ assessment information. Here, all experts independently provide their assessments on all attributes about all alternatives by using their utility of grades.

Step 3. Decide attribute weights by experts.

Step 4. Form the combined group decision assessments on each alternative of each attribute. Then, we calculate the aggregated group decision assessments on each alternative using ER algorithm.

Step 5. Obtain the aggregated utility of grades.

Step 6. Generate a final ranking order of \( m \) alternatives.

Step 7. End.

The procedure is demonstrated in Figure 2.
Vidential Reasoning of these six attributes in Table 1. A set of grades to appropriate
Selection of alternatives about security of wireless sensor networks
Collection of information from some experts
Construction of decision matrix provided by some experts
Determination of attribute weights
Aggregation of information on each attribute
Rank all alternatives

**Figure 2.** The procedure of the evidential reasoning

3. THE APPLICATION OF EVIDENTIAL REASONING IN SELECTION AN APPROPRIATE WIRELESS SENSOR NETWORK

In this section, the proposed ER algorithm is applied to assess security of wireless sensor networks using MATLAB 2013.

As mentioned in Introduction, there are some characteristic of wireless sensor networks including self-organizing nature, limited bandwidth and distributed operations. For users, they may focus on the data which are collected from sensor nodes. Ruan (Ruan, 2009) pointed out that because of the limited energy, communication ability, computing speed and storage of the sensors, the existing traditional security mechanism has not suited for the development of wireless sensor networks especially for the need of the consumers and enterprises. Then, a new system for evaluating security of wireless sensor networks is necessary and important.

Based on the existing studies, an attribute system to assess the security of wireless sensor networks is constructed in the Figure 1.

Firstly, we invited three experts denoted by $E_1$, $E_2$ and $E_3$ as the decision makers to provide their assessments of four alternatives denoted by $A_1$, $A_2$, $A_3$ and $A_4$ on the six attributes denoted by $D_1$, $D_2$, $D_3$, $D_4$, $D_5$ and $D_6$ as mentioned in Figure 1. The experts give the weight vector of these six attributes in Table 1. A set of grades to evaluate the four alternatives on six attributes is set, i.e., $\Omega = \{H_1, H_2, H_3, H_4\} = \{\text{Poor performance}, \text{Average performance}, \text{Good performance}, \text{Very Good performance}, \text{Excellent performance}\} = \{R, A, D, Y, T\}$. The experts set the utility of each grade to be $(0, 0.25, 0.5, 0.75, 1)$. Then, based on their preferences of every alternative on each attribute, the experts construct a decision matrix showed in Table 2 – Table 4. Step 1 and Step 2 are completed.

| Table 1: Weights of each attribute provided by each expert |
|---|---|---|---|---|---|
| $E_1$ | $D_1$ | $D_2$ | $D_3$ | $D_4$ | $D_5$ | $D_6$ |
| $E_1(\ast 0.01)$ | 2 | 15 | 2 | 15 | 1 | 2 |
| $E_3(\ast 0.01)$ | 25 | 17 | 23 | 12 | 8 | 15 |
| $E_4(\ast 0.01)$ | 22 | 18 | 15 | 2 | 15 | 1 |

| Table 2: Decision matrix provided by expert $E_1$ |
|---|---|---|---|---|---|
| $A_1$ | $D_1$ | $D_2$ | $D_3$ | $D_4$ | $D_5$ | $D_6$ |
| $(R,0.4),(A,0.3),(D,0.3)$ | $(A,0.4),(Y,0.4),(D,0.3)$ | $(A,0.2),(D,0.3),(D,0.3)$ | $(A,0.3),(D,0.3),(D,0.3)$ | $(G,0.4),(Y,0.4),(D,0.3)$ | $(T,0.4),(D,0.4),(D,0.4)$ | $(T,0.4),(D,0.5),(D,0.5)$ |
| $(A,0.6),(D,0.4)$ | $(D,0.5),(Y,0.4),(D,0.1)$ | $(R,0.4),(A,0.3),(D,0.3)$ | $(R,0.3),(A,0.4),(D,0.3)$ | $(A,0.1),(Y,0.7),(D,0.2)$ | $(T,0.4),(T,0.4),(D,0.4)$ | $(T,0.5),(D,0.4),(D,0.4)$ |
| $(A,0.8),(D,0.2)$ | $(R,0.4),(D,0.4),(D,0.3)$ | $(D,0.2),(Y,0.3),(E,0.5)$ | $(R,0.4),(D,0.6),(T,0.2)$ | $(A,0.3),(Y,0.5),(D,0.2)$ | $(T,0.7),(D,0.2),(T,0.2)$ |
| $(D,0.5),(Y,0.1)$ | $(R,0.3),(A,0.3),(D,0.4)$ | $(Y,0.6),(T,0.4)$ | $(R,0.2),(G,0.3),(D,0.5)$ | $(T,0.6),(D,0.4)$ | $(A,0.4),(Y,0.2),(D,0.4)$ |
A appropriate solution of this problem, as a typical group decision making method to solve uncertain decision problems is introduced in many experts to help us solve this problem which could be considered as a group decision making problem. Then security of wireless sensor networks has attracted much attention from many researchers. In this paper, we invite domains. How to select an appropriate alternative from some wireless sensor nodes which can supervise the environment, acquire sensor data and transmit sensor data to the monitoring center through multi-hop routing. With the rapid development of technology, wireless sensor networks have been widely applied in many practical fields such as agriculture, structure monitoring, gas detection, medical treatments, health monitoring, military, E-commerce and so on. Although wireless sensor networks are beneficial for our life and society, it brought some problems. As technology develops rapidly, wireless sensor networks have been widely applied in many practical fields such as agriculture, structure monitoring, gas detection, medical treatments, health monitoring, military, E-commerce and so on. Although wireless sensor networks are beneficial for our life and society, it brought some problems. In general, wireless sensor network consists of low-cost, low-power tiny sensor nodes which could detect physical phenomena and communicate with each other to transmit sensor data to base station. As technology develops rapidly, wireless sensor networks have been widely applied in many practical fields such as agriculture, structure monitoring, gas detection, medical treatments, health monitoring, military, E-commerce and so on. Although wireless sensor networks are beneficial for our life and society, it brought some problems. For example, when information of consumers leaks in a wireless sensor network, it may bring bad influence for these consumers or enterprises. Security is an important factor when we apply wireless sensor networks into many domains. How to select an appropriate alternative from some wireless sensor networks from the perspective of security of wireless sensor networks has attracted much attention from many researchers. In this paper, we invite many experts to help us solve this problem which could be considered as a group decision making problem. Then, ER algorithm, as a typical group decision making method to solve uncertain decision problems is introduced in this paper. Finally, a case study is demonstrated to verify the validity of the proposed model and obtain an appropriate solution of this problem.

### Table 3 Decision matrix provided by expert $E_2$

<table>
<thead>
<tr>
<th>$E_2$</th>
<th>$D_1$</th>
<th>$D_2$</th>
<th>$D_3$</th>
<th>$D_4$</th>
<th>$D_5$</th>
<th>$D_6$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A_1$</td>
<td>$[(D.0.7),(Y.0.2),(\Omega.01)];$</td>
<td>$[(R.0.2),(A.0.2),(\Omega.02)];$</td>
<td>$[(A.0.8),(\Omega.2)];$</td>
<td>$[(A.0.3),(D.0.4),(\Omega.0.3)];$</td>
<td>$[(D.0.7),(Y.0.1),(\Omega.2)];$</td>
<td>$[(R.0.5),(A.0.5)];$</td>
</tr>
<tr>
<td>$A_2$</td>
<td>$[(A.0.2),(D.0.5),(\Omega.0.3)];$</td>
<td>$[(A.0.4),(D.0.4),(\Omega.02)];$</td>
<td>$[(R.1)];$</td>
<td>$[(D.0.8),(\Omega.0.2)];$</td>
<td>$[(R.0.5),(Y.0.5)];$</td>
<td>$[(Y.0.5),(T.0.4),(\Omega.0.1)];$</td>
</tr>
<tr>
<td>$A_3$</td>
<td>$[(A.0.5),(D.0.5)];$</td>
<td>$[(Y.0.4),(E.0.5)];$</td>
<td>$[(A.0.1),(A.0.3),(G.0.6)];$</td>
<td>$[(T.0.6),(\Omega.0.4)];$</td>
<td>$[(Y.0.8),(\Omega.2)];$</td>
<td>$[(Y.0.5),(T.0.4),(\Omega.0.1)];$</td>
</tr>
<tr>
<td>$A_4$</td>
<td>$[(D.0.4),(Y.0.4),(\Omega.0.2)];$</td>
<td>$[(D.0.6),(Y.0.4)];$</td>
<td>$[(R.0.2),(A.0.3),(\Omega.0.5)];$</td>
<td>$[(D.0.5),(Y.0.4),(\Omega.0.1)];$</td>
<td>$[(D.0.3),(Y.0.6),(\Omega.01)];$</td>
<td>$[(D.0.8),(T.0.1),(\Omega.0.1)];$</td>
</tr>
</tbody>
</table>

### Table 4 Decision matrix provided by expert $E_3$

<table>
<thead>
<tr>
<th>$E_3$</th>
<th>$D_1$</th>
<th>$D_2$</th>
<th>$D_3$</th>
<th>$D_4$</th>
<th>$D_5$</th>
<th>$D_6$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A_1$</td>
<td>$[(R.0.3),(A.0.4),(\Omega.0.5)];$</td>
<td>$[(R.0.5),(A.0.3),(\Omega.02)];$</td>
<td>$[(A.0.8),(D.0.2)];$</td>
<td>$[(P.0.2),(G.0.5),(\Omega.0.3)];$</td>
<td>$[(D.0.9),(\Omega.2)];$</td>
<td>$[(R.0.8),(A.0.2)];$</td>
</tr>
<tr>
<td>$A_2$</td>
<td>$[(R.0.6),(\Omega.0.4)];$</td>
<td>$[(D.1)];$</td>
<td>$[(R.0.8),(A.0.2)];$</td>
<td>$[(D.0.5),(\Omega.0.5)];$</td>
<td>$[(A.0.5),(D.0.5)];$</td>
<td>$[(Y.0.5),(T.0.5)];$</td>
</tr>
<tr>
<td>$A_3$</td>
<td>$[(D.0.8),(\Omega.0.1),(\Omega.0.1)];$</td>
<td>$[(Y.0.5),(\Omega.0.5)];$</td>
<td>$[(R.0.3),(D.0.3),(\Omega.0.7)];$</td>
<td>$[(D.0.6),(T.0.4)];$</td>
<td>$[(Y.0.8),(T.0.2)];$</td>
<td>$[(D.0.2),(T.0.5),(\Omega.0.3)];$</td>
</tr>
<tr>
<td>$A_4$</td>
<td>$[(A.0.9),(\Omega.0.1)];$</td>
<td>$[(D.0.9),(\Omega.0.1)];$</td>
<td>$[(R.0.1),(A.0.4),(\Omega.0.5)];$</td>
<td>$[(D.0.4),(Y.0.4),(E.0.2)];$</td>
<td>$[(D.0.5),(Y.0.5)];$</td>
<td>$[(D.0.8),(\Omega.0.2)];$</td>
</tr>
</tbody>
</table>

Based on ER algorithm and using Eqs. (3) – (8) twice, assessments provided by experts on each attribute in Table 2 – Table 4 are aggregated into an aggregated assessment of each alternative. Then, by using utility to transform each aggregated assessment into an expected utility of each alternative as mentioned in Eqs. (3) – (8), the rank-order can be generated in the Table 5.

### Table 5 The rank-order

<table>
<thead>
<tr>
<th>rank</th>
<th>$A_1$</th>
<th>$A_2$</th>
<th>$A_3$</th>
<th>$A_4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

From Table 5, the rank-order is demonstrated as $A_3 \succ A_4 \succ A_1 \succ A_2$. Obviously, it is known that $A_3$ is the optimal alternative which has the best security performance. This result can not only help the manager select an appropriate wireless sensor network, but also let manager realize relative role of alternative. Moreover, it can further promote the development of wireless sensor networks through the analysis of assessment results. But this work may be the next plan.

### 3. CONCLUSION

With the rapid development of technology, wireless sensor network is composed of large amount of tiny sensor nodes which can supervise the environment, acquire sensor data and transmit sensor data to the monitoring center through multi-hop routing. In general, wireless sensor network consists of low-cost, low-power tiny sensor nodes which could detect physical phenomena and communicate with each other to transmit sensor data to base station. As technology develops rapidly, wireless sensor networks have been widely applied in many practical fields such as agriculture, structure monitoring, gas detection, medical treatments, health monitoring, military, E-commerce and so on. Although wireless sensor networks are beneficial for our life and society, it brought some problems. For example, when information of consumers leaks in a wireless sensor network, it may bring bad influence for these consumers or enterprises. Security is an important factor when we apply wireless sensor networks into many domains. How to select an appropriate alternative from some wireless sensor networks from the perspective of security of wireless sensor networks has attracted much attention from many researchers. In this paper, we invite many experts to help us solve this problem which could be considered as a group decision making problem. Then, ER algorithm, as a typical group decision making method to solve uncertain decision problems is introduced in this paper. Finally, a case study is demonstrated to verify the validity of the proposed model and obtain an appropriate solution of this problem.
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