African Journal of Agricultural Research Vol. 5(13), pp.1549-1552, 4 July, 2010
Available online at http://www.academicjournals.org/AJAR
ISSN 1991-637X ©2010 Academic Journals

Review

Unascertained number in grain emergency

Liu Guangli*, Li Di and Gao Youjian

College of Information and Electrical Engineering, China Agricultural University, Beijing, 100083, China.

Accepted 1 December, 2009

Path selection problems for grain emergency are uncertainties. According to unascertained theory, the opinions of experts in related fields can be unascertained number, as well as the definition of mathematical expectation to rationally integrate. A new model and the algorithm for path choosing is proposed based on minimum risk in the process of grain emergency transportation. First of all, by the estimated time of each path, several expert advice unascertained number available. Then, based on unascertained number of addition and multiplication rules, comprehensive expert advice you unascertained number can be calculated. Then again, the unascertained number of expectations and credibility can be calculated. Finally, the expectations of unascertained numbers add up, and the estimated time of the known path, thereby minimizing the risk of the shortest path can be calculated. Experimental data show that the proposed model has a certain rationality and effectiveness.

Key words: Unascertained number, grain emergency, risk.

INTRODUCTION

Unusual snow raid over southern provinces of China in 2008 has been the worst in the last five decades. It has resulted in huge losses in structural collapse, blackouts, acidents, transport problems. Meanwhile, the grain supplies emergency response plan was activated due to the lack of food and vegetables. Natural disasters, sanitation events, terrorism, local military clashes, such things which can lead to shortage of supplement happen every now and then. However, some of these chaoses can not be forecasted by human. Even when there are reports, time for response ahead of the disaster is too short. At this situation, the importance of the emergency attempter and transportation is unusual. To increase the ability of government, enterprise and social organization on solving the problems of the emergency attempter and transportation became a task. When things happen, the traffic condition will be concerned seriously, thus choosing a best path which costs the shortest time to transport food supplements will maximize the effect of emergency transportation. The research of grain emergency transportation will tell people which path is the best one to choose to make the supply arrive faster and safer.

The demand of the grain supply should be as soon as possible, but the traffic problems in disaster are hard to be estimated, the strong power of the disaster can make some roads impassable. The decision-maker may not have a totally view of the environment status to choose which path to go, some real difficulty in transportation will make an uncertain transportation time. At this time, the decision-maker may take some experts' consultations. The experts who have rich knowledge in different fields may correct the experiential value using their experiences (Guo-feng, 2008; Zhi-min and Nai-yang, 2004).

Decision making is the outcome which is selected through mental processes from some alternative options. To achieve a certain purpose, besides considering the history data, the decision maker must make the most satisfied plan by analyzing, comparing and judging a number of the possible factors which could happen. However, the uncertain factors in modern society are difficult to cover due to the limitation of the knowledge of one person. It has to find a method to consider both the experiential value and the estimated value scientifically. In this paper, a method using the unascertained number to gain the minimum risk value in the net will be introduced (Shu-ping and San-yang, 2003; Sheng-fa et al., 2008).

UNASCERTAINED NUMBER

There is uncertain information in the objective world

*Corresponding author. E-mail: liugl@cau.edu.cn.

besides random information and fuzzy information. This kind of information is subjective uncertainty which happens because of the lack of the acquaintance of things around and it is called uncertain information. Based on uncertain information the basement of uncertain mathematics is founded. Pro Wu and Pro Liu defined unascertained number, uncertain set and so on. The model is based on the theory of the uncertain math. In the following section, two definitions will be given to tell the foundational theory of uncertain math (Kai-di et al., 1999).

Define 1. For any closed interval [*a, b*], x_i, [*a, b*], and $x_1 < x_2 < ... < x_n$, if $\varphi(x)$ meets the condition

$$\varphi(x) = \begin{cases} \sigma_i, x = x_i, i = 1,2,...,n \\ 0, x \neq x_i, x \in R \end{cases},$$

And $\sum_{i=1}^{n} \sigma_i = \sigma, 0 < \sigma_i \leq 1, 0 < \sigma \leq 1, i = 1,2,...,n$, then [*a, b*] and $\varphi(x)$ are called a *n*-order unascertained number, written $[[a,b],\varphi(x)]$. We take σ as the total reliability of the unascertained number, $[a,b]$ as the value range, $\varphi(x)$ as the distribution density function. We call $\{x_i\}$ as the sequence of possible values of this unascertained number, $\{\sigma_i\}$ as the sequence of the credibility of this unascertained number, $i = 1,2,...,n$.

Example 1. Let

$$\varphi(x) = \begin{cases} 0.16, x = 0.1 \\ 0.32, x = 0.2 \\ 0.16, x = 0.5 \\ 0.16, x = 9.0 \\ 0, x \notin \{0.1, 0.2, 0.5, 9.0\}, x \in R \end{cases}$$

Then $[[0.1, 9.0], \varphi(x)]$ is an unascertained number.

Apparently, $0.16 + 0.32 + 0.16 + 0.16 = 0.8 < 1$, the reason for this is the value or information we get may not cover the whole possibilities because of the conditional restriction. So, the total credibility of these 5 values may be less than 1.

Define 2. Suppose $A = [[x_1, x_n], f(x)]$, $B = [[y_1, y_m], g(y)]$ as two unascertained numbers,

$$f(x) = \begin{cases} \alpha_i, x = x_i \\ 0, x \neq x_i, x \in [x_1, x_n] \end{cases}$$

$$g(y) = \begin{cases} \beta_j, y = y_j \\ 0, y \neq y_j, y \in [y_1, y_m] \end{cases}$$

$\{x_i\}(i = 1,2,...,n)$ and $\{y_j\}(j = 1,2,...,m)$ are the sequence of possible values of A and B separately. $\{\alpha_i\}(i = 1,2,...,n)$ and $\{\beta_j\}(j = 1,2,...,m)$ are the sequence of the credibility of A and B separately. The Matrix

$$\begin{bmatrix} x_1 + y_1 & x_1 + y_2 & ... & x_1 + y_m \\ x_2 + y_1 & x_2 + y_2 & ... & x_2 + y_m \\ ... & ... & ... & ... \\ x_n + y_1 & x_n + y_2 & ... & x_n + y_m \end{bmatrix}$$

is called the sum matrix of A and B. The matrix

$$\begin{bmatrix} \alpha_1\beta_1 & \alpha_1\beta_2 & ... & \alpha_1\beta_m \\ \alpha_2\beta_1 & \alpha_2\beta_2 & ... & \alpha_2\beta_m \\ ... & ... & ... & ... \\ \alpha_n\beta_1 & \alpha_n\beta_2 & ... & \alpha_n\beta_m \end{bmatrix}$$

is called the reliability of the product matrix of A and B.

The elements $x_i + y_j$ and $\alpha_i\beta_j$ in the same place row i, column j in the two matrices are called the corresponding elements, $i = 1,2,...,n$; $j = 1,2,...,m$.

Placing the elements in the sum matrix of A and B value in an ascending order, $z_1, z_2, ..., z_l$, the same elements are taken as one. Place the corresponding elements in the matrix product of A and B in a sequence $\sigma_1, \sigma_2, ..., \sigma_l$. If z_i express the same S elements in the sum matrix A and B, then σ_i express the sum of the same S elements in the matrix product of A and B. We call unascertained number $C = [[z_1, z_l], \varphi(z)]$ as the sum of A and B, marked $C = A + B$,

$$\varphi(z) = \begin{cases} \sigma_i, z = z_i \\ 0, z \neq z_i, z \in R \end{cases}$$

In definition 2, we can make the matrix of difference, product, quotient $\left(y_j \neq 0, j=1,2,...,m\right)$ to get $A-B$, $A\times B$ and $A\div B$.

GRAIN EMERGENCY MODEL AND ALGORITHM

As mentioned before, the experiential value may not be the correct value in picking the minimum risk path in the net. By the knowledge the experts have, they can estimate diverse practical values of the time which the transportation will take. Due to the limitation of one's field, different experts have different authority and reliability. In this case, we use unascertained number to express the values that experts estimate.

In the emergency net system, we set a limit time t. Now abstract this net to a weight graph G. Every side e of this graph has an experiential weight $w(e)$ which expressed $[a,b]$. Now there are several experts value this side e, and they themselves has a limit on the situation so their reliability are different, too. Now we will modify $w(e)$.There are m experts E_i, $i=1,2,...,m$. Their reliabilities are R_i, $i=1,2,...,m$. E_i values $w(e)$ as unascertained number A_i $(i=1,2,...,m)$. Considering m Experts' ideas, we will get a new unascertained number $A=\sum_{i=1}^{m}\beta_i A_i$, and $\beta_i A_i=\left[\left[\beta_i x_{i1},\beta_i x_{ik}\right],\varphi_i(x)\right]$,

$$\varphi_i(x)=\begin{cases}\alpha_{ij}, x=\beta_i x_{ij}\ (j=1,2,...,k), 0\le\sum_{j=1}^{k_i}\alpha_{ij}=\alpha\le 1\\ 0, x\,\overline{\in}\left\{\beta_i x_{i1},...,\beta_i x_{ik_i}\right\}, x\in R\end{cases}$$

Base on the unascertained number algorithm,

$$A=\sum_{i=1}^{m}\beta_i A_i=\left[\left[a,b\right],\varphi(x)\right]$$, and

$$a=\min\left\{x_{1k}+x_{2l}+...+x_{m\theta}\right\},$$
$$b=\max\left\{x_{1k}+x_{2l}+...+x_{m\theta}\right\}$$

$$\left(k=1,2,...,k_1;l=1,2,...,k_2;...;\theta=1,2,...,k_m\right)$$

$$\varphi(x)=\begin{cases}\varphi_1(x_{1k})\varphi_2(x_{2l})...\varphi_m(x_{m\theta}), x=x_{1k}+x_{2l}+...+x_{m\theta}\\ 0, x\neq x_{1k}+x_{2l}+...+x_{m\theta}, x\in R\end{cases}$$

Base on the unascertained number expectation

$$E(A)=\left[\left[\frac{1}{\alpha}\sum_{i=1}^{k}x_i\alpha_i,\frac{1}{\alpha}\sum_{i=1}^{k}x_i\alpha_i\right],\varphi(x)\right]$$, and

$$\sum_{i=1}^{k}\alpha_i=\alpha\le 1,\alpha\in\left(0,1\right]$$.

DATA EXPERIMENTS

Suppose snow disaster happens in a place, and several tons of grains are needed. Between the emergency spot and the grain bins around, there are still some roads to choose. Now choose one in the net as the transportation path. However, this snow disaster goes on, the reliability of this road is unsure. So experts estimate this path considering the situation they can imagine.

Suppose there are three experts, and the situation of the road is not clear. By considering the condition around, expert A thinks the possibility of passing this road in 1 h is 0.2; the possibility of passing this road in 2 h is 0.5. Expert B thinks the possibility of passing this road in 2 h is 0.3, the possibility of passing this road in 3 h is 0.5. Expert C thinks the possibility of passing this road in 1 h is 0.3, the possibility of passing this road in 4 h is 0.6. These three experts' reliability are separately A: 0.2, B: 0.3, C: 0.5.

According to the expressions,

$$A=\sum_{i=1}^{m}\beta_i A_i=\left[\left[1.3,3.3\right],\varphi(x)\right]$$

$$\varphi(x)=\begin{cases}0.018, x=1.3; 0.045, x=1.5; 0.030, x=1.6\\ 0.075, x=1.8; 0.036, x=2.8; 0.090, x=3.0\\ 0.060, x=3.1; 0.150, x=3.3;\\ 0, x\,\overline{\in}\,\{1.3,1.5,1.6,1.8,2.8,3.0,3.1,3.3\}, x\in R\end{cases}$$

The expectation is $E(A)=2.63$ h. It means that, considering all experts' idea, it most likely to take about 2.63 h passing this road.

CONCLUSION

The expert decisions modify the value of the path in the net, so we can get a value which is closer to the real one. This model has been used in a grain emergency transportation system. However, even the weight in the net is reevaluated via the experts' consultations, the reliability of each expert is now decided by the decision maker, and it's still a kind of subjective decision. So find a way to estimate the reliability is necessary. In addition, we will consider modifying the empirical value with the expectation, to get a precise path weight. The expectation is a real number which cannot operate with interval number, so we can consider that put these two kinds of numbers into a wider range which called grey number. This question was not taken into account, may be further proof is needed.

ACKNOWLEDGEMENT

It is a project supported by “Eleventh Five-Year” National Science and Technology Support Program funded projects (2008BADA8B01-2, 2006BAJ07B09).

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