Fuzzy Decision Model for Mandarin Testing System Evaluation

Lin Tang
School of Humanities, Sichuan University of Science & Engineering, Sichuan, CHINA

ABSTRACT
Mandarin is the official language of China, and the government attaches great importance to the mandarin education. In the past years, the Mandarin test is mainly based on manual testing, in recent years, the testing systems come out. For the many kinds of Mandarin testing systems, it is hard to evaluate which one is suitable for Mandarin test. In this paper, we discuss the prerequisite of testing system, and a bidding decision model is produced based on fuzzy optimum decision method. This method is a scientific guidance for Mandarin testing system choice.

Keywords— Fuzzy Decision Model, Testing System, Evaluation

I. INTRODUCTION
With the continuous development of Mandarin level test, the role of Mandarin testing system is getting greater and greater. Mandarin test has important and positive significance to improve the standard of Mandarin pronunciation, popularize the scope of Putonghua speaking. This is very significant. In order to simplify the Mandarin testing process, and save the human and material resources, people design the Mandarin testing system. There are many kinds of Mandarin testing systems come out in the bidding process. How to select the best one is a difficult problem. There are many methods for optimum selection [1-4]. Fuzzy optimum decision method[5-7] is a good way to do scientific decision. The main purpose of the fuzzy decision is to introduce some new behaviors into the decision methods, and lead to the fair decision. And the minimum subordinate degree method is useful [8-10].

In this paper, we use the minimum subordinate degree method to generate a fuzzy decision model to help people select the suitable Mandarin testing system.

II. PRELIMINARIES

2.1 Subordinative Degree

Let \( u_i \) denote the element in the set \( U \), and we assume there are \( m \) elements in the set \( U \).

\[
U = \{u_1, u_2, u_3, \ldots, u_m\}.
\]

The subordinative degree set is

\[
A = (a_1, a_2, \ldots, a_m)
\]

where, \( \sum_{i=1}^{m} a_i = 1 \), \( a_i \geq 0 \) (\( i = 1, 2, \ldots, m \)).

The subordinative degrees are always determined by using the subordinative degree function.

2.2 Subordinative Degree Function

Let \( F_i \) be the set of performance properties (\( i = 1, 2 \)). The range of \( F_i \) is \( d_i = [m_i, M_i] \), where \( m_i \) is the minimum value of \( F_i \), and \( M_i \) is the maximum value of \( F_i \). We denote \( S_j = S_{F_i}(x_j), j = 1, 2, \ldots, m \) be the subordinative degree function of \( x_i \) in set \( F_i \), where, \( S_j \in [0,1] \).

The cost category \( F_1 \):

\[
S_j = \begin{cases} 
1, & x_i \leq m_1 \\
\frac{M_1 - x_i}{M_1 - m_1}, & x_i \in d_1 \\
0, & x_i \geq M_1 
\end{cases}
\]

The benefit category \( F_2 \):

\[
S_j = \begin{cases} 
0, & x_i \leq m_2 \\
\frac{x_i - m_2}{M_2 - m_2}, & x_i \in d_2 \\
1, & x_i \geq M_2 
\end{cases}
\]
Let $Y = \{y_1, y_2, \cdots, y_p\}$ be the set of bidding schemes, $x_1, x_2, \cdots, x_i$ are the evaluation factors. In the testing system, we need some function values of factors as small as possible. The objective function is

$$\Gamma_1(x_i) = \min \{f_{y_1}(x_i), f_{y_2}(x_i), \cdots, f_{yp}(x_i)\}.$$ 

And some function values of factors should be as greater as possible. The objective function is

$$\Gamma_2(x_i) = \max \{f_{y_1}(x_i), f_{y_2}(x_i), \cdots, f_{yp}(x_i)\}.$$ 

Without loss of generality, we assume $f_{h_1}(x_1), f_{h_2}(x_2), \cdots, f_{h_r}(x_r)$ are belong to the cost category, and $f_{h_{r+1}}(x_{r+1}), f_{h_{r+2}}(x_{r+2}) \cdots f_{h_l}(x_l)$ are belong to benefit category, where, $f_{h_i}(\cdot) > 0$ and $h \in Y = \{y_1, y_2, \cdots, y_p\}$.

The subordinative degree function can be defined as follows.

Cost category.

$$\mu_i(f_{h_i}(x_i)) = \frac{M_i - f_{h_i}(x_i)}{M_i - \Gamma_1(x_i)},$$

where, $h \in Y$, $i = 1, 2, \cdots, r$.

Benefit category.

$$\mu_j(f_{h_j}(x_j)) = \frac{f_{h_j}(x_j) - m_j}{\Gamma_2(x_j) - m_j}$$

where, $h \in Y$, $j = r+1, r+2, \cdots, l$.

Our aim is to find the optimum objective values, so we give out the idea values, which are the minimum value in cost category and the maximum value in benefit category.

$$f^0 = (f^0_1, f^0_2, \cdots, f^0_l),$$

where $f^0_i = \min(f_{h_i}(x_i))$, $f^0_j = \max(f_{h_j}(x_j))$, $i = 1, 2, \cdots, r$.

We use the method of minimum subordinative degree to get the optimum value. The mean absolute deviation value of $f_i(x)$ is

$$\mu(f_i(x))$$

$$= \frac{1}{l} \sum_{j=1}^{l} |\mu_i(f_i(x_j)) - \mu_i(f^0_i)|$$

(3)

$$= \frac{1}{l} \sum_{j=1}^{l} |\mu_i(f_i(x_j)) - 1|$$

The mean absolute deviation values are

$$\mu(f(x)) = (\mu(f_1(x), \mu(f_2(x), \cdots, \mu(f_l(x))$$

Thus the optimum value is

$$\min \mu(f_i(x)) = \min \frac{1}{l} \sum_{j=1}^{l} |\mu_i(f_i(x_j)) - 1|$$

The corresponding scheme of the optimum value is the bid-winning scheme.

Remark. The computation algorithm can be shown in Fig. 1.

IV. APPLICATION

We consider the following factors of Mandarin proficiency testing system, shown in Fig. 2.

We assume there are 6 bidding systems, and the values of evaluation factors are shown in Table 1.

The price and retardation should be as small as possible, and the factors in the right hand of Fig.2 should be as great as possible. We give the weights to indices, perfect to be 1, good to be 0.8, normal to be 0.5. According to the equation (1) and (2), Table 1 can be transformed to be Table 2.

From Table 2, the idea value $f^0 = (30, 0.02, 1, 2.5, 1, 1)$. According to the equation (3), we know

$$\mu(f(x)) = (0.38, 0.1, 0.51, 0.45, 0.47, 0.37)$$

The minimum value is 0.1, which means the best system is system 2.

V. CONCLUSION

Mandarin testing system is very important, which is a kind of software for measuring mandarin level. In this paper, based on fuzzy optimum decision method, a scientific method to select a suitable Mandarin testing system is give. And the example shows the feasibility of the scheme. Our scheme can give the guidance for the selection of the Mandarin testing system.
Select Subordinative Degree Function $S_i$

Compute Subordinative Degree $u_i(f(x_i))$

Determine Ideal Values $f^*$

Compute Mean Absolute Deviation Value $u(f(x_i))$

Compute Minimum Deviation Value $\min u(f(x_i))$

Fig.1 Computation Algorithm

Bidding System

Price

Retardation

Accuracy

Anti-Interference

Storage Space

Stability

Fig.2 Main Factors of Bidding System

Table 1 Values of Evaluation factors

<table>
<thead>
<tr>
<th>System</th>
<th>Price</th>
<th>Retardation</th>
<th>Accuracy</th>
<th>Storage Space</th>
<th>Anti-Interference</th>
<th>Stability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30</td>
<td>0.05</td>
<td>good</td>
<td>1</td>
<td>normal</td>
<td>normal</td>
</tr>
<tr>
<td>2</td>
<td>40</td>
<td>0.02</td>
<td>perfect</td>
<td>2.5</td>
<td>good</td>
<td>perfect</td>
</tr>
<tr>
<td>3</td>
<td>50</td>
<td>0.05</td>
<td>good</td>
<td>0.5</td>
<td>normal</td>
<td>normal</td>
</tr>
<tr>
<td>4</td>
<td>35</td>
<td>0.06</td>
<td>normal</td>
<td>1.5</td>
<td>normal</td>
<td>normal</td>
</tr>
<tr>
<td>5</td>
<td>45</td>
<td>0.10</td>
<td>normal</td>
<td>2.5</td>
<td>good</td>
<td>normal</td>
</tr>
<tr>
<td>6</td>
<td>55</td>
<td>0.08</td>
<td>good</td>
<td>2</td>
<td>perfect</td>
<td>perfect</td>
</tr>
</tbody>
</table>

Table 2 Values of every factor

<table>
<thead>
<tr>
<th>System</th>
<th>Price</th>
<th>Retardation</th>
<th>Accuracy</th>
<th>Storage Space</th>
<th>Anti-Interference</th>
<th>Stability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0.625</td>
<td>0.8</td>
<td>0.25</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>2</td>
<td>0.6</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.8</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>3</td>
<td>0.2</td>
<td>0.625</td>
<td>0.8</td>
<td>0.25</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>4</td>
<td>0.8</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>5</td>
<td>0.4</td>
<td>0</td>
<td>0.5</td>
<td>1</td>
<td>0.8</td>
<td>0.5</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>0.25</td>
<td>0.8</td>
<td>0.75</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

REFERENCES


