Available online at www.sciencedirect.com
ScienceDirect
Advances in Engineering Software 39 (2008) 137–145
ADVANCES IN ENGINEERING SOFTWARE
www.elsevier.com/locate/advengsoft

A Matlab toolbox for grey clustering and fuzzy comprehensive evaluation

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Received 22 September 2006; received in revised form 25 November 2006; accepted 4 December 2006
Available online 21 February 2007

Abstract

In this article, we propose totally new grey clustering method and fuzzy comprehensive evaluation method and accordingly, a Matlab toolbox for grey clustering statistic and fuzzy comprehensive evaluation is developed. As an illustrative example, we use the toolbox developed for carrying on an analysis of the test scores of the Grade 3 at the National Changhua Girls' Senior High School, Taiwan. The evaluation process successfully shows that the toolbox is fairly convenient, very useful and quite efficient.

Keywords: Grey clustering method; Fuzzy comprehension evaluation method; Matlab toolbox; Students' quality evaluation

1. Introduction

In this paper, the main study is based on grey clustering and fuzzy comprehension evaluation, to develop an evaluation toolbox, and to apply it in students' test scores in the education field. Traditionally, when using the statistical method in analyzing an issue, the summation method has mostly been used to get an average value, and the standard deviation method can only be used to reach a simple conclusion [1]. In past research in this field, only a few papers have touched on this field, such as efficiency promotion, educational ability, the optimal teacher evaluation in the study of teaching and course design [2]. Some toolboxes had been developed, but it is still felt that there are some weak points [3–6]. Also, it is known that software plays an important role in our life system, because it will not only cause significant effects in the operation of a real system, but it will also make the results more convincing and practical. Secondly, Matlab is the foundation of the software research training in a university. The main advantage of Matlab is that it does not only make students understand the computer software, but also can be used in other applications. Hence, in this article, Matlab is used to develop the grey clustering and fuzzy comprehension evaluation toolbox [7,8].

The mathematical method is presented in Section 2, which includes grey clustering and fuzzy comprehension evaluation [9]. In Section 3, the Matlab is used to develop the required computer software toolbox. In Section 4, the examination results of the third grade (in the medical and agriculture fields) at the National Changhua Girls' Senior High School are used as an example [10], and the toolbox is used to record the results. Finally, some advantages and disadvantages of this method are presented, and some suggestions made toward further research.

2. Mathematical model

2.1. Grey statistic

In this subsection, a grey statistic concept is proposed. We describe the basic definition and construction approach in step by step manner as following [11,12].

1. Grey whiteness function
   Assume $f(x)$ is a linear monotonic function of x, x is the grey number, and $f(x) \in [0,1]$. Then $f(x)$ is called the

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doi:10.1016/j.advengsoft.2006.12.002

whitenization weight function, where $\max\cdot\{f(x)\}=1$ [13], and divided into High, Middle and Low levels, and the values in whitenization weigh is given objectively (see Fig. 1).
2. The kernel of grey statistic
Let whitenization weight functions $f_1, f_2, f_3, \ldots, f_l$ be defined respectively as objective as possible.

Definition 1. $a_1, a_2, a_3, \ldots, a_m$ are the statistical objects. $b_1, b_2, b_3, \ldots, b_n$ are the statistical indexes. $f_1, f_2, f_3, \ldots, f_l$ are the grey whiteness functions where: $m, n, l \in N$, and d_{ij} are the sample values for the objects, which d_{ij}, $1 \leqslant i \leqslant m$, $1 \leqslant j \leqslant n$.

Definition 2. D is the matrix which contain d_{ij} elements

$$D=\begin{bmatrix} d_{11} & d_{12} & \cdots & d_{1n} \\ d_{21} & d_{22} & \cdots & d_{2n} \\ \cdots & \cdots & \ddots & \vdots \\ d_{m1} & d_{m2} & \cdots & d_{mn} \end{bmatrix} \tag{1}$$

Definition 3. F is a mapping, and op$[f_k(d_{ij})]$ is the operation of $f_k\ (d_{ij})$, then

$$F: op[f_k(d_{ij})] \to \sigma_{jk} \in [0,1] \tag{2}$$

where $1 \leqslant k \leqslant l$, $1 \leqslant i \leqslant m$, $1 \leqslant j \leqslant n$, resulting in

$$\sigma_j = (\sigma_{j1,}\sigma_{j2}, \sigma_{j3}, \ldots, \sigma_{jl}) \tag{3}$$

then σ_j is called "weighting vector sequence of b_j", and F is called grey statistic.

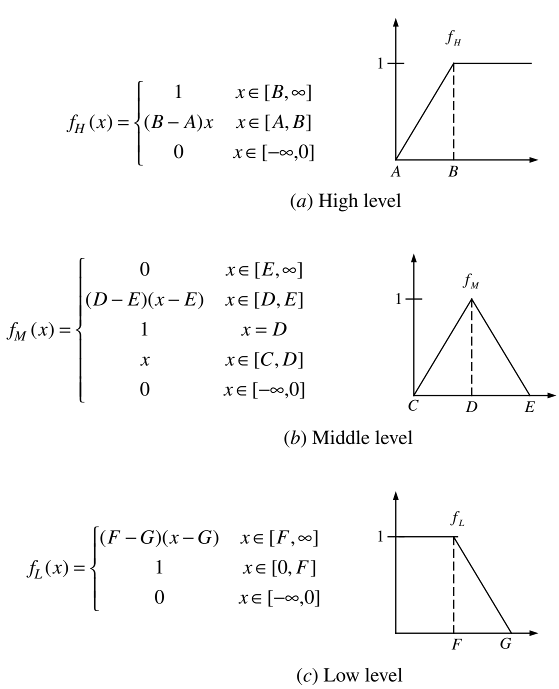


Fig. 1. The whiteness function: (a) high level, (b) middle level and (c) low level.

3. The operating steps of grey statistic
   (1) Giving the whiteness function $f_1, f_2, f_3, \ldots, f_l$ objectivity.
   (2) Calculating the value of index j corresponding to the whiteness function $f_k(d_{ij})$.

$$\begin{aligned} \sum_{i=1}^{m} f_1 &= f_1(d_{1j}) + f_1(d_{2j}) + f_1(d_{3j}) + \cdots + f_1(d_{mj}) \\ \sum_{i=1}^{m} f_2 &= f_2(d_{1j}) + f_2(d_{2j}) + f_2(d_{3j}) + \cdots + f_2(d_{mj}) \\ \sum_{i=1}^{m} f_3 &= f_3(d_{1j}) + f_3(d_{2j}) + f_3(d_{3j}) + \cdots + f_3(d_{mj}) \\ &\cdots\cdots\cdots\cdots\cdots\cdots \\ \sum_{i=1}^{m} f_l &= f_l(d_{1j}) + f_l(d_{2j}) + f_l(d_{3j}) + \cdots + f_l(d_{mj}) \end{aligned} \tag{4}$$

   (3) Calculating the summation of index j:

$$\sum f = \sum_{i=1}^{m} f_1 + \sum_{i=1}^{m} f_2 + \sum_{i=1}^{m} f_3 + \cdots + \sum_{i=1}^{m} f_l \tag{5}$$

   (4) Normalization of the weighting vector sequence:

$$\sigma_{j1} = \frac{\sum_{i=1}^{m} f_1}{\sum f}, \sigma_{j2} = \frac{\sum_{i=1}^{m} f_2}{\sum f}, \ldots, \sigma_{jl} = \frac{\sum_{i=1}^{m} f_l}{\sum f} \tag{6}$$

   (5) Taking the maximum value of σ_j

$$\max\cdot(\sigma_j) = \max\cdot(\sigma_{j1}, \sigma_{j2}, \sigma_{j3}, \ldots, \sigma_{jl}) \tag{7}$$

   (6) Repeating steps 1 through 5, to find the other objects.

2.2. Fuzzy comprehension evaluation

The second topics in this section is fuzzy comprehension evaluation, and the whole analysis steps is shown below step by step [14,15].

1. Build the factor set U:

$$U = (u_1, u_2, u_3, \ldots, u_m) \tag{8}$$

where u_i, $i = 1, 2, 3, \ldots, m$ are the influence factors.
2. Build the fuzzy weighting set a_i to correspond to each influencing factor (based on Zadeh method):

$$\widetilde{A} = \frac{a_1}{u_1} + \frac{a_2}{u_2} + \frac{a_3}{u_3} + \cdots + \frac{a_m}{u_m} \tag{9}$$

where $\sum_{i=1}^{m} a_i = 1$.
3. Build the evaluation set: V

$$V = (v_1, v_2, v_3, \ldots, v_m) \tag{10}$$

4. Calculate the fuzzy relationship: $\widetilde{R}_i$

$$\widetilde{R}_i = \frac{r_{i1}}{v_1} + \frac{r_{i2}}{v_2} + \frac{r_{i3}}{v_3} + \cdots + \frac{r_{in}}{v_n} \tag{11}$$

Translate Eq. (11) into fuzzy evaluation matrix:

$$\widetilde{R}_i = \begin{bmatrix} r_{11} & r_{12} & \ldots & r_{1n} \\ r_{21} & r_{22} & \ldots & r_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{m1} & r_{m2} & \ldots & r_{mn} \end{bmatrix} \tag{12}$$

5. Calculate the evaluation index: The rule of operation is defined as:

$$B = \widetilde{A} \circ \widetilde{R} = (a_1, a_2, a_3, \ldots, a_m) \circ \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix} = (b_1, b_2, b_3, \ldots, b_n) \tag{13}$$

6. Based on fuzzy method, the evaluation results are calculated as follows:
   (1) Maximum–Minimum method

$$b_j = \bigvee_{i=1}^{m} (a_i \wedge r_{ij}), \quad j = 1, 2, 3, \ldots, n \tag{14}$$

   (2) Minimum–Maximum method

$$b_j = \bigwedge_{i=1}^{m} (a_i \vee r_{ij}), \quad j = 1, 2, 3, \ldots, n \tag{15}$$

   (3) Maximum–Maximum method

$$b_j = \bigvee_{i=1}^{m} (a_i \vee r_{ij}), \quad j = 1, 2, 3, \ldots, n \tag{16}$$

   (4) Minimum–Minimum method

$$b_j = \bigwedge_{i=1}^{m} (a_i \wedge r_{ij}), \quad j = 1, 2, 3, \ldots, n \tag{17}$$

3. The development of toolbox

3.1. The characteristic of the toolbox

In this paper, we developed two toolbox, the whole structure of toolbox is shown in Fig. 2.

3.2. The characteristic of the toolbox

During the development of software, Matlab has been very convenient and practical software for researchers. It is very easy to be operated due to its wide coverage, Assembly-based language, and the very simple algorithms. It is possible for the users to develop their own calculation functions and integrate them into the toolbox; this can enhance the Matlab functions to a great deal. It's also very convenient to process graphics with Matlab. The graphics can be displayed as soon as the data are loaded into the Matlab system. In addition, there are many other toolboxes in Matlab for convenient operation with specific calculations for users of different application domains [7]. Due to the reasons above, if the soft computing toolbox can be designed with combination of the advantages of Matlab, the research problems can be solved with ease. It will be also convenient to develop related software with Matlab as the core. The users can develop new toolboxes according to their own research topics with Matlab as the base.

3.3. The software requirements

1. Windows 2000 or upgrade version.
2. The resolution of screen at least 1024×768.
3. Matlab 5.3 or upgrade version.

3.4. The operation of grey statistic toolbox

1. Start the toolbox
2. Matlab system
   (1) Input your data: $d = [a_1, b_1, c_1, d_1, \ldots; a_2, b_2, c_2, d_2, \ldots; a_n, b_n, c_n, d_n, \ldots]$
   where: a_1, b_1, c_1, $d_1, \ldots$; a_2, b_2, c_2, $d_2, \ldots$; a_n, b_n, c_n, d_n: The target.
   (2) Input the range of whiteness function: $w = [A\ B\ C\ D\ E\ F\ G]$
   where: $[A\ B]$: The range of high level, $[C\ D\ E]$: The range of middle level, $[F\ G]$: The range of low level.
   (3) Input the instruction: newgreycluster(d,w): Enter.

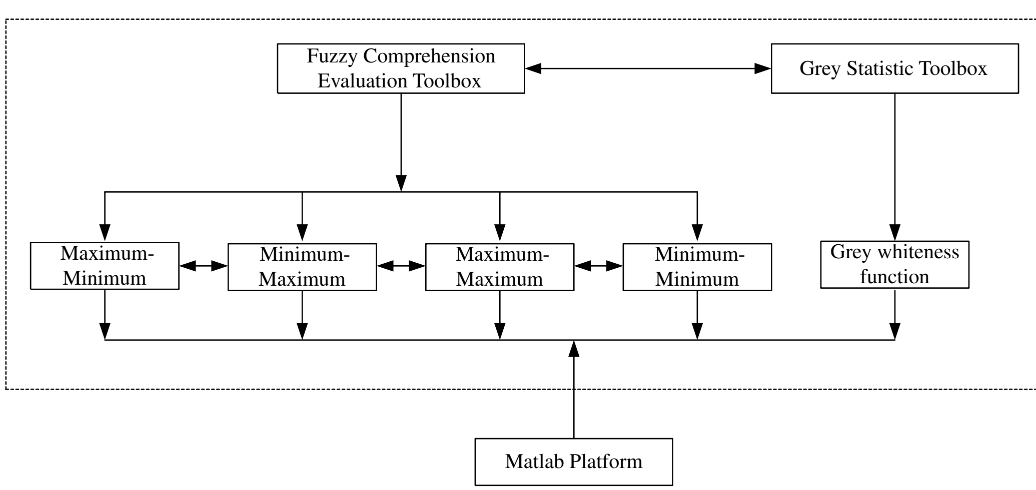


Fig. 2. The whole structure of our research.

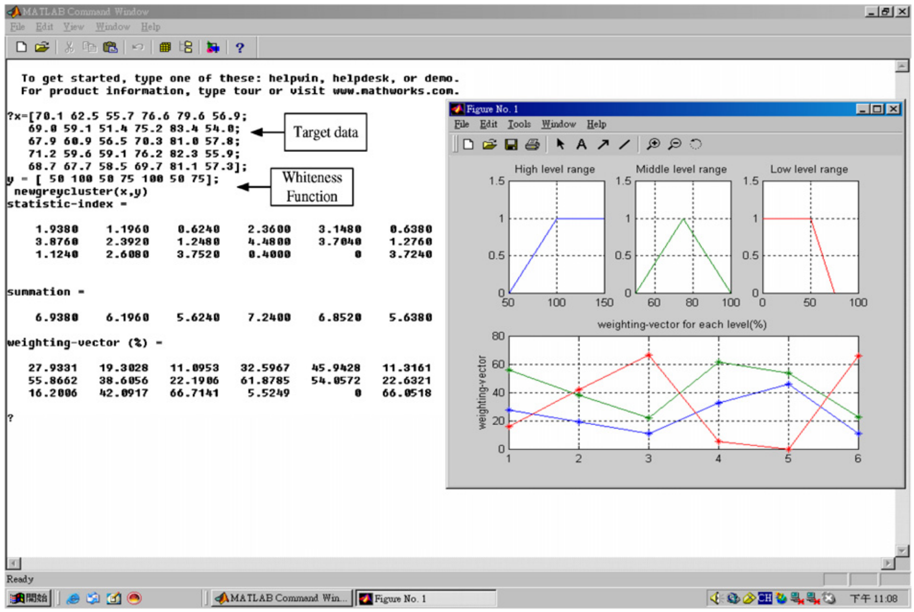


Fig. 3. The display for grey statistic.

3. Matlab platform: Display original data, statistics index and its summation, weighting vector sequence and the distribution figure under percentage type (please see Fig. 3).

3.5. The operation of fuzzy comprehension evaluation toolbox

1. Start the toolbox
2. Matlab system
   (1) Input your data: $f = [A_1, B_1, C_1, D_1, \ldots; \ A_2, B_2, C_2, D_2, \ldots; \ldots; A_n, B_n, C_n, D_n, \ldots]$
   where $[A_1, B_1, C_1, \ \ D_1, \ldots; A_2, B_2, C_2, D_2, \ldots; \ldots; A_n, B_n, C_n, D_n, \ldots]$:
   The fuzzy weighting set for each level (such as 1st level, 2nd level, 3rd level, ..., nth level)
   (2) Input the membership function: $r = [a_1, b_1, c_1, d_1, \ldots; a_2, b_2, c_2, d_2, \ldots; \ldots; a_n, b_n, c_n, d_n, \ldots]$
   where: $[a_1, b_1, c_1, d_1, \ldots; a_2, b_2, c_2, d_2, \ldots; \ldots; a_n, b_n, c_n, d_n, \ldots]$: The fuzzy evaluation matrix.
   (3) Input the instruction: newfuzzy-xxxxxx(f,r): Enter.
   where: -xxxxxx is name of the method.
3. Matlab platform: Display the values of fuzzy weighting set (matrix form), relationship matrix, weighting of each factor and after normalization, distribution figure under percentage type (from Figs. 4–7).

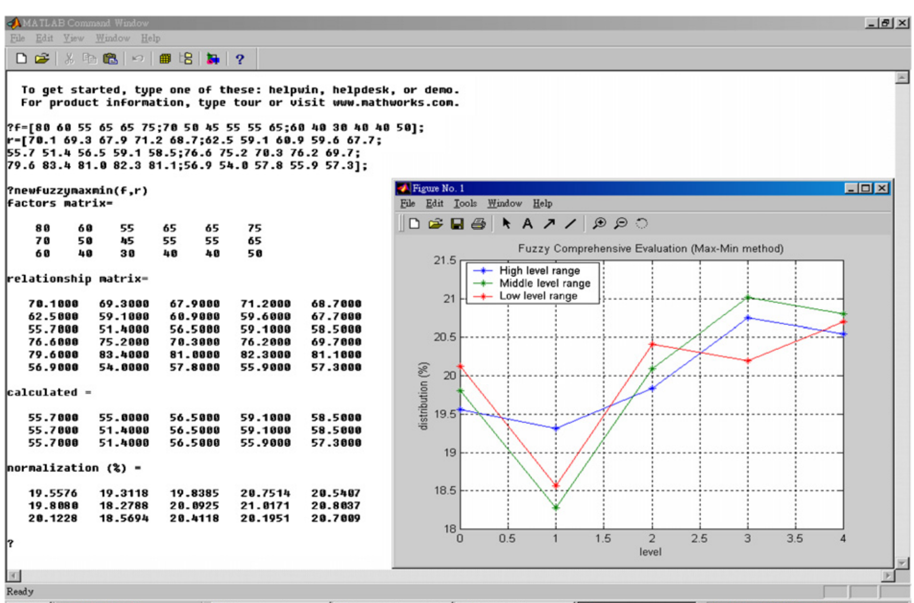


Fig. 4. The display of fuzzy comprehension evaluation (Maximum–Minimum method for all levels).

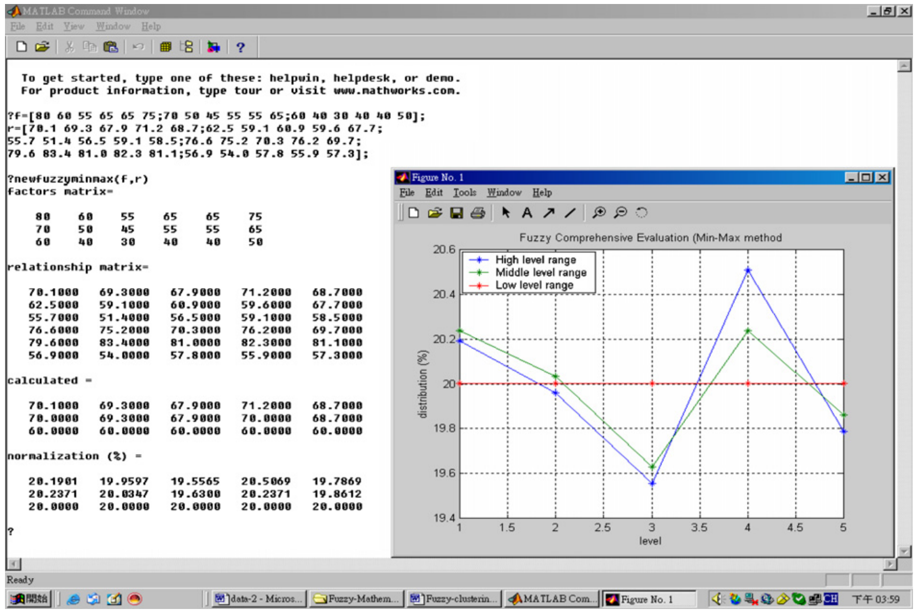


Fig. 5. The display of fuzzy comprehension evaluation (Minimum–Maximum method for all levels).

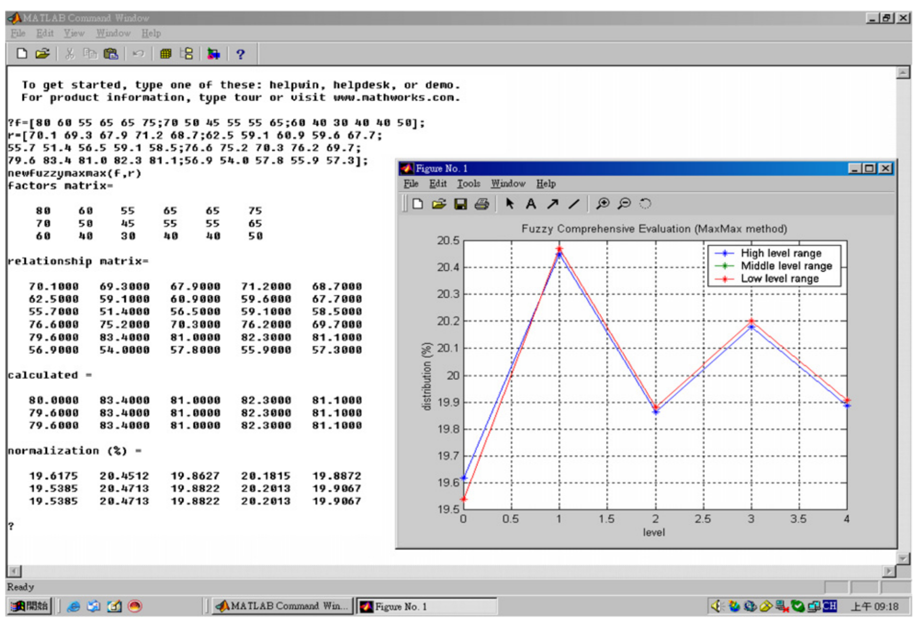


Fig. 6. The display of fuzzy comprehension evaluation (Maximum–Maximum method for all levels).

4. Example

4.1. The pre-assumptions

1. The statistical objects are the third grade students (in the medicine and agriculture fields): class 302 (47 students), class 303 (47 students), class 304 (46 students), class 305 (45 students) and class 306 (42 students). Total: 5 classes (227 students) [6].
2. The statistic indexes are the average score of the 1st examination in six courses: Chinese, English, Mathematics, Chemistry, Physics and Biology for 2003 (see Table 1).

4.2. By using the grey statistics, the calculated results for the 1st examination are as follows

1. The statistical clustering is divided into three levels: high, middle and low levels.
2. According to the education concept, the grey whiteness function can be divided into three parts, and are shown in Fig. 8.

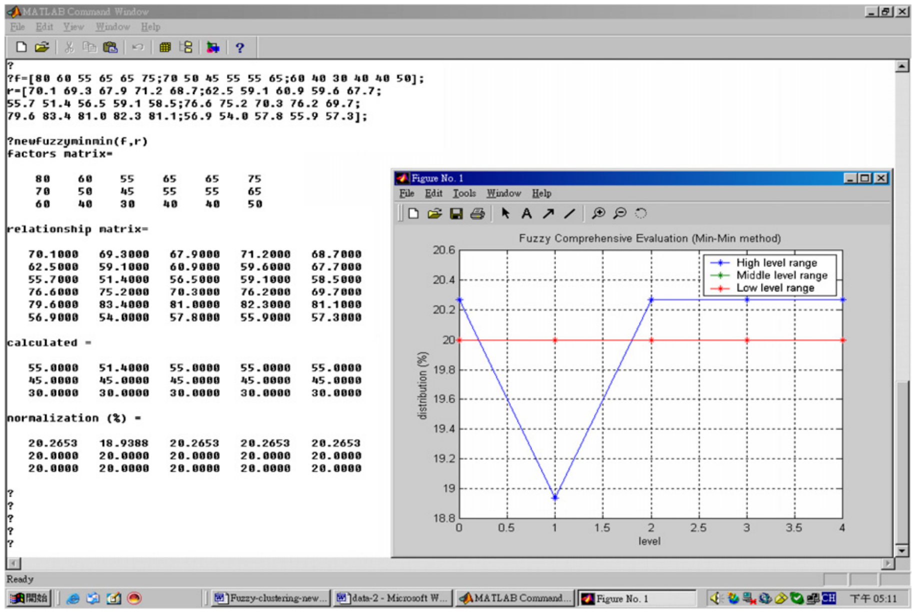


Fig. 7. The display of fuzzy comprehension evaluation (Minimum–Minimum method for all levels).

3. Build the D matrix: The 1st examination:

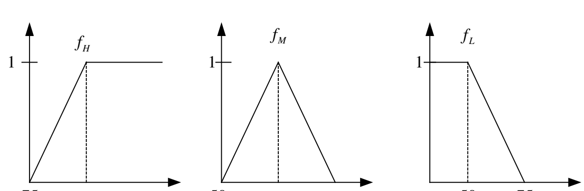
$$d = \begin{bmatrix} 70.1 & 62.5 & 55.7 & 76.6 & 79.6 & 56.9 \\ 69.3 & 59.1 & 51.4 & 75.2 & 83.4 & 54.0 \\ 67.9 & 60.9 & 56.5 & 70.3 & 81.0 & 57.8 \\ 71.2 & 59.6 & 59.1 & 76.2 & 82.3 & 55.9 \\ 68.7 & 67.7 & 58.5 & 69.7 & 81.1 & 57.3 \end{bmatrix}$$

4. The calculated results

   According to the given grey whiteness function as shown in Fig. 5, f_1 is at a high level, f_2 is at the middle level and f_3 is at the low level.

Table 1
The test score in National Changhua Girl Senior High School for 1st examination

Class	Average score					
	Chinese	English	Mathematics	Chemistry	Physics	Biology
302	70.1	62.5	55.7	76.6	79.6	56.9
303	69.3	59.1	51.4	75.2	83.4	54.0
304	67.9	60.9	56.5	70.3	81.0	57.8
305	71.2	59.6	59.1	76.2	82.3	55.9
306	68.7	67.7	58.5	69.7	81.1	57.3



(*a*) High level (*b*) Middle level (*c*) Low level

Fig. 8. The distribution of grey whiteness function in our example: (a) high level, (b) middle level and (c) low level.

(1) The grey statistic of the Chinese score: $\max\cdot(\sigma_1) = \max\cdot(0.0000, 0.7752, 0.2248) = 0.7752 = \sigma_{12}$.
(2) The grey statistic of the English score: $\max\cdot(\sigma_2) = \max\cdot(0.0000, 0.4784, 0.5216) = 0.5216 = \sigma_{23}$.
(3) The grey statistic of the Mathematics score: $\max\cdot(\sigma_3) = \max\cdot(0.0000, 0.2496, 0.7504) = 0.7504 = \sigma_{33}$.
(4) The grey statistic of the Chemistry score: $\max\cdot(\sigma_4) = \max\cdot(0.0240, 0.8960, 0.0800) = 0.8960 = \sigma_{42}$.
(5) The grey statistic of the Physics score: $\max\cdot(\sigma_5) = \max\cdot(0.7408, 0.2592, 0.0000) = 0.7408 = \sigma_{51}$.
(6) The grey statistic of the Biology score: $\max\cdot(\sigma_6) = \max\cdot(0.0000, 0.2552, 0.7448) = 0.7448 = \sigma_{63}$.

These results are shown in Table 2.

4.3. By using the fuzzy comprehension evaluation, the calculated results for the 1st examination are as follows

1. Building the factor set, i.e. the scores of six courses. U = (Chinese, English, Mathematics, Chemistry, Physics, Biology)
2. Building the fuzzy weighting set a_i to correspond with each influencing factor (please see Table 3).

Table 2
The grey statistic method

Course	Clustering		
	High (%)	Middle (%)	Low (%)
Chinese	0.0000	0.7752	0.2248
English	0.0000	0.4784	0.5216
Mathematics	0.0000	0.2496	0.7504
Chemistry	0.0240	0.8960	0.0800
Physics	0.7408	0.2592	0.0000
Biology	0.0000	0.2552	0.7488

(1) high level is (80, 60, 55, 65, 65, 75).
(2) middle level is (70, 50, 45, 55, 55, 65).
(3) low level is (60, 40, 30, 40, 40, 50).

3. Building the evaluation set, i.e. the 5 classes, which means $V = (302, 303, 304, 305, 306)$.
4. Calculating the fuzzy relationship: by using Table 4, but changing the column and row.

$$\widehat{R} = \begin{bmatrix} 70.1 & 69.3 & 67.9 & 71.2 & 68.7 \\ 62.5 & 59.1 & 60.9 & 59.6 & 67.7 \\ 55.7 & 51.4 & 56.5 & 59.1 & 58.5 \\ 76.6 & 75.2 & 70.3 & 76.2 & 69.7 \\ 79.6 & 83.4 & 81.0 & 82.3 & 81.1 \\ 56.9 & 54.0 & 57.8 & 55.9 & 57.3 \end{bmatrix}$$

5. Calculating the evaluation index
(1) Minimum–Maximum method
(i) high level: $B = \widetilde{A} \circ \widetilde{R} = (80, 60, 55, 65, 65, 75) \circ \widehat{R} = (70.1, 69.3, 67.9, 71.2, 68.7)$
(ii) middle level: $B = \widetilde{A} \circ \widetilde{R} = (70, 50, 45, 55, 55, 65) \circ \widehat{R} = (70, 69.3, 67.970, 68.7)$
(iii) low level: $B = \widetilde{A} \circ \widetilde{R} = (60, 40, 30, 40, 40, 50) \circ \widehat{R} = (60, 60, 60, 60, 60)$

The evaluation result after normalization is:
(i) high level: (0.201901, 0.199759, 0.195565, 0.205069, 0.197869)
(ii) middle level: (0.202371, 0.200347, 0.196300, 0.202371, 0.198662)
(iii) low level: (0.200000, 0.200000, 0.200000, 0.200000, 0.200000)

These results are shown in Table 5.

Table 3
The fuzzy weighting set a_i to correspond to each influencing factor in our example

Class	Average score					
	Chinese	English	Mathematics	Chemistry	Physics	Biology
High level	80	60	55	65	65	75
Middle level	70	50	45	55	55	65
Low level	60	40	30	40	40	50

Table 4
The fuzzy relationship in National Changhua Girl Senior High School for 1st examination

Average score	Class				
	302	303	304	305	306
Chinese	70.1	69.3	67.9	71.2	68.7
English	62.5	59.1	60.9	59.6	67.7
Mathematics	55.7	51.4	56.5	59.1	58.5
Chemistry	76.6	75.2	70.3	76.2	69.7
Physics	79.6	83.4	81.0	82.3	81.1
Biology	56.9	54.0	57.8	55.9	57.3

Table 5
The Minimum–Maximum method in fuzzy comprehension evaluation

Valuation index	High (%)	Middle (%)	Low (%)
302	20.1901	20.2371	20.0000
303	19.9759	20.0347	20.0000
304	19.5565	19.6300	20.0000
305	20.5069	20.2371	20.0000
306	19.7869	19.8612	20.0000

(2) Maximum–Minimum method
(i) high level: $B = \widetilde{A} \circ \widetilde{R} = (80, 60, 55, 65, 65, 75) \circ \widehat{R} = (55.7, 55, 56.5, 59.1, 58.5)$
(ii) middle level: $B = \widetilde{A} \circ \widetilde{R} = (70, 50, 45, 55, 55, 65) \circ \widehat{R} = (55.7, 51.4, 56.5, 59.1, 58.5)$
(iii) low level: $B = \widetilde{A} \circ \widetilde{R} = (60, 40, 30, 40, 40, 50) \circ \widehat{R} = (55.7, 51.4, 56.5, 55.9, 57.3)$

The evaluation result after normalization is:
(i) high level: (0.195576, 0.193118, 0.198385, 0.207514, 0.205407)
(ii) middle level: (0.198080, 0.182788, 0.200925, 0.210171, 0.208037)
(iii) low level: (0.201228, 0.185694, 0.204118, 0.201951, 0.207009)

These results are shown in Table 6.

(3) Maximum–Maximum method
(i) high level: $B = \widetilde{A} \circ \widetilde{R} = (80, 60, 55, 65, 65, 75) \circ \widehat{R} = (80, 83.4, 81, 82.3, 81.1)$
(ii) middle level: $B = \widetilde{A} \circ \widetilde{R} = (70, 50, 45, 55, 55, 65) \circ \widehat{R} = (79.6, 83.4, 81.0, 82.3, 81.1)$
(iii) low level: $B = \widetilde{A} \circ \widetilde{R} = (60, 40, 30, 40, 40, 50) \circ \widehat{R} = (79.6, 83.4, 81.0, 82.3, 81.1)$

The evaluation result after normalization is:
(i) high level: (0.196175, 0.204512, 0.198627, 0.201815, 0.198872)
(ii) middle level: (0.195385, 0.204713, 0.198822, 0.202013, 0.199067)
(iii) low level: (0.195385, 0.204713, 0.198822, 0.202013, 0.199067)

These results are shown in Table 7.

(4) Minimum–Minimum method
(i) high level: $B = \widetilde{A} \circ \widetilde{R} = (80, 60, 55, 65, 65, 75) \circ \widehat{R} = (55, 51.4, 55, 55, 55)$
(ii) middle level: $B = \widetilde{A} \circ \widetilde{R} = (70, 50, 45, 55, 55, 65) \circ \widehat{R} = (45, 45, 45, 45, 45)$

Table 6
The Maximum–Minimum method in fuzzy comprehension evaluation

Evaluation index	High (%)	Middle (%)	Low (%)
302	19.5576	19.8080	20.1228
303	19.3118	18.2788	18.5694
304	19.8385	20.0925	20.4118
305	20.7514	21.0171	20.1951
306	20.5407	20.8037	20.7009

Table 7
The Maximum–Maximum method in fuzzy comprehension evaluation

Evaluation index	High (%)	Middle (%)	Low (%)
302	19.6175	19.5385	19.5385
303	20.4512	20.4713	20.4713
304	19.8627	19.8822	19.8822
305	20.1815	20.2013	20.2013
306	19.8872	19.9067	19.9067

(iii) low level: $B = \widetilde{A} \circ \widetilde{R} = (60, 40, 30, 40, 40, 50) \circ \widehat{R} = (30, 30, 30, 30, 30)$

The evaluation result after normalization is:

(i) high level: (0.202648, 0.189388, 0.202653, 0.202653, 0.202653)

(ii) middle level: (0.200000, 0.200000, 0.200000, 0.200000, 0.200000)

(iii) low level: (0.200000, 0.200000, 0.200000, 0.200000, 0.200000)

These results are shown in Table 8.

Table 8
The Minimum–Minimum method in fuzzy comprehension evaluation

Evaluation index	High (%)	Middle (%)	Low (%)
302	20.2648	20.0000	20.0000
303	18.9388	20.0000	20.0000
304	20.2653	20.0000	20.0000
305	20.2653	20.0000	20.0000
306	20.2653	20.0000	20.0000

Table 9
The analysis results of 1st examination by using traditional summation method

Course	Summation method	Grade
Chinese	$(70.1 + 69.3 + 67.9 + 71.2 + 68.7)/5 = 69.44$	C
English	$(62.5 + 59.1 + 60.9 + 59.6 + 67.7)/5 = 61.96$	C
Mathematic	$(55.7 + 51.4 + 56.5 + 59.1 + 58.5)/5 = 56.24$	D
Chemistry	$(76.6 + 75.2 + 70.3 + 76.2 + 69.7)/5 = 73.60$	B
Physics	$(79.6 + 83.4 + 81.0 + 82.3 + 81.1)/5 = 81.48$	A
Biology	$(56.9 + 54.0 + 57.8 + 55.9 + 57.3)/5 = 56.38$	C

Table 10
The analysis results of 1st examination by using standard deviation method

Course	Standard deviation method	Grade
Chinese	1.1377	I
English	3.1020	III
Mathematic	2.7229	II
Chemistry	2.9806	II
Physics	1.2859	I
Biology	1.3437	I

4.4. By using the traditional method, the calculated results for the 1st examination are as follows

As per the example in this article, if the traditional method is used, only the rank of each score and the grade can be obtained, it cannot supply the detail that is required (please see Tables 9 and 10).

5. Conclusions and discussion

In previous development of the soft computing software design, the focus was only on a case study, but it is known that soft computing often contains complex operations and plenty of graphic demonstrations, and it poses a certain difficult in software design. Therefore, in view of using the Matlab to design the soft computing toolbox, it has the following academic implications:

1. To make a designer thoroughly understands the whole essential meaning in grey statistics and fuzzy comprehension evaluation.
2. It is easy to write and in fact its grammar does not present any difficulty, and it is portable. In addition, it is user-friendly for human interface, and the total required memory space is quite small.
3. The numbers of grey whiteness level, fuzzy weighting set and fuzzy evaluation matrix can be easily extended to what is wanted.
4. As for the economy aspect, the price of one ordinary set of Matlab is about \$850 (2006). Although it is very expensive, Matlab is at least one hundred times more functional over any basic language program (such as C^{++} and VB) and encompasses the convenience and the output expansion.

Besides, in this paper, by using grey statistics and the fuzzy comprehension evaluation, the distribution for each course in each class can be found. If the traditional summation method is used, only the simple different grades in each course are obtained, while the standard deviation method result is the same as the traditional summation method. The distribution cannot be obtained by using the grey and fuzzy methods.

To sum up, the soft computing toolbox of grey statistics and the fuzzy comprehension evaluation has been developed. Some contributions in the grey and fuzzy theories have been presented. This study presents both theoretical and practical significances, especially in student test score appraisal.

However, some weaknesses still exist, such as, the values of the fuzzy weighting set are objective; the number of the grey whiteness function level, hence, there are different grey whiteness levels and values of the fuzzy weighting set which will derive different results. Therefore, it is suggested that a combination of the different grey whiteness function levels and the fuzzy comprehension evaluation methods with different levels and values of the fuzzy weighting set, should be applied in other relative fields. This is the key point for future research.

Acknowledgements

The author wants to thank the Chienkuo Technology University and Chinese Grey System Association (CGSA). This article was partially supported and the project extended under CTU-95-RP-EE-001-013-A.

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