

Applying *Matlab* to create a grey entropy toolbox for use in teacher appraisals

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ABSTRACT: Teacher appraisals in the education field have become very important and necessary in the 21st Century. Although there have been some ripe methods developed in the past, such as student gains by testing, institutional self-study by staff, transaction observations, management analysis, social policy analysis and adversary evaluation, fuzzy results still exist in past appraisal methods and the solution was non-unique. Therefore, in this article, the authors present the grey entropy method as a new approach for teacher appraisals. In this article, the authors first discuss the teacher appraisal principle. Next, grey entropy is introduced. The researchers selected 20 teachers from Chienkuo Technology University (CTU), Changhua, Taiwan, to act as participants. The authors next discuss the grey entropy toolbox, which is based on *Matlab*, and how it has been developed. The results show that the grey entropy method is quite useful for this case.

INTRODUCTION

Appraising teachers is a current trend in the entire educational world. It can be used to raise the entire teaching quality at different types of schools. Constructing an appropriate system of teachers' evaluations to raise the quality of teachers is an important key in coping with changes in society and ensuring the effects of education reform.

The quality of teachers and their teaching quality are closely related to the effect of education. Teachers can change students' behaviour, nurture good habits and stimulate students' potential through the course. A merit system can reward teachers with good performance, allow teachers with relatively poorer performance to self-critique and improve, and allow ineligible teachers to find other, more suitable, working environments [1]. Further, evaluation is a judgement of the value of oneself and one's surroundings.

Evaluation is not a new concept; it has existed in human society for a long time. Teaching evaluations can be used to understand whether or not certain teaching methods used by teachers are appropriate, as well as to analyse whether or not teaching goals have been achieved. Hence, it can be shown that evaluations provide important indicators in the effects of teaching, and the degree to which key goals have been achieved [2].

A merit system can be divided into several parts, with the assessment and evaluation of teachers in educational works as one emphasis. However, when carrying out evaluations in the past, mathematical methods were commonly used [2]. In statistics, a mean value is used to describe the measures of a central location from a set of numbers. The so-called measures of central location serve to select optimal representative values from the central state of every point score of collected information [3]. This result may be very fuzzy due to the fact that, other than equal weight for every item, subjective and

partial factors, data are multivariate and discrete, resulting in an unfair assessment of teacher performance, and the loss of accuracy and validity of the evaluation. In the field of studies of the relation between grey theory and education over the past few years, several papers have focused on the field of teacher evaluation [4]. Therefore, in this article, the authors advance the use of grey entropy for performance appraisal to counter the shortcomings mentioned above.

In the next section, the authors explain the mathematical foundation of grey entropy in detail [5]. Then, 20 teachers from Chienkuo Technology University (CTU), Changhua, Taiwan, are engaged as examples for implementing the new approach. Under the condition of not setting the standard value, the authors analyse the relative optimisation among the evaluated teachers to assist in educational works [6]. The grey entropy toolbox based on *Matlab* is then developed for these needs [7].

GREY ENTROPY

The main function of grey entropy is to measure the weighting in discrete sequences [8]. Hence, the authors use grey entropy as a starting point, and then describe the whole concept of grey entropy step-by-step in detail, with the aim to present the entire system. The whole concept is shown below [5].

The Mathematical Method

If a finite set, \hat{A} , is in the whole set, and a mapping exists $f_i: [0,1] \rightarrow [0,1]$, $i=1,2,3,\dots,n$, and satisfies three conditions: $f_i(0)=0$; $f_i(x)=f_i(1-x)$; and $f_i(x)$ is monotonic in the range $x \in (0,0.5)$, then we have:

$$d(A) = g\left[\sum_{i=1}^n c_i f_i(\hat{A}(u_i))\right] \quad (1)$$

where: 1. $g(x)$ is monotonic in the range $[0, a] \rightarrow [0,1]$.

With $c_i \in R$, let

$$a = \sum_{i=1}^m c_i f_i(0.5) \quad (2)$$

then, it is considered that $d(A)$ is the entropy of set \hat{A} .

According to above-mentioned conditions, a the new entropy is defined, called grey entropy. Hence:

$$W(\hat{A}) = \frac{1}{0.6478} \sum_{i=1}^m W_e(X_i) \quad (3)$$

when taking $c_1 = c_2 = c_3 = \dots = c_m = 1$ in equation (2), the following value is obtained: $\frac{1}{0.6478}$;

$W(x) = [xe^{(1-x)} + (1-x)e^x - 1]$ gives a plot diagram (Figure 1).

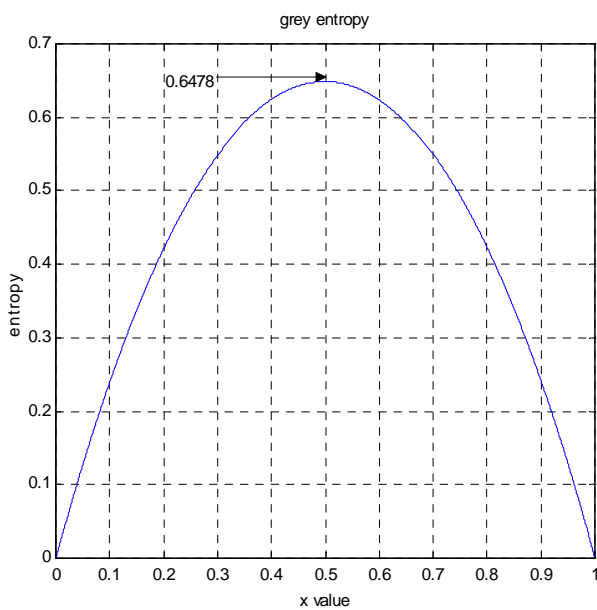


Figure 1: Grey entropy.

Analysis Steps

The sequence is set as follows:

$$x_i = (x_i(1), x_i(2), x_i(3), \dots, x_i(k)) \quad (4)$$

where: $i = 1, 2, 3, \dots, m, k = 1, 2, 3, \dots, n$

The total sum of each factor's attribute is calculated:

$$D_k = \sum_{i=1}^m x_k(i) \quad (5)$$

The normalisation coefficient is calculated:

$$k = \frac{1}{0.6478 \times m} \quad (6)$$

The entropy of each factor is calculated:

$$e_k = \frac{1}{0.6478 \times m} \sum_{i=1}^m W_e\left(\frac{x_i(k)}{D_k}\right) \quad (7)$$

The sum of entropy is calculated:

$$E = \sum_{i=1}^n e_k \quad (8)$$

The relative weighting is calculated:

$$\lambda_k = \frac{1}{m-E} [1 - e_k] \quad (9)$$

Normalisation the weighting is calculated:

$$\beta_k = \frac{\lambda_k}{\sum_{i=1}^n \lambda_i} \quad (10)$$

in which β_k is the weight for each factor.

THE TEACHER APPRAISAL

In this study, the authors utilised a comparison of the annual point chart of teachers at Chienkuo Technology University as a case (for 20 instructors). Under the condition of not setting the standard value, the authors analysed the relative optimisation among the evaluated teachers to assist in educational works.

Analysis of Every Item of the Studied Factors

A description of the analysis of every item of the studied factors is as follows (see also Table 1):

- Attendance at every meeting: The purpose of this is to transform the focus from the school to the student, and gain feedback from students. A perfect score is ten points, with a deduction of 0.5 point for every absence.
- Teaching time and class meeting tutoring: The purpose of this is communication with students, and to help them to solve their problems. A perfect score is ten points, with the deduction of 0.5 point for every absence.
- Student affection points: The purpose of this is the basic interaction between teacher and student. A perfect score is 12 points, the grading is in accordance with the following clauses and the five-level grading (excellent, very good, good, not good and awful). The questions are as listed follows:

- Was it easy to find the instructor to request absence?
- Did the instructor often find time to visit and tutor students outside of instruction time?
- What was the effect of the instructor on tutoring students during lunch breaks?
- What was the effect of the instructor in assisting the cleaning works of students?
- What was the effect of the instructor in assisting students with their clothing and appearance?
- Did the instructor find time to participate in every activity in the class? [6].

The method of evaluation is to hand out N copies of the questionnaires. Points are assigned as follows: excellent (five points); very good (four points); good (three points); not good (two points); and awful (one point).

The calculation equation is:

$$\text{score} = \frac{5A + 4B + 3C + 2D + E}{2.5N} \quad (11)$$

where:

- A = the number of *excellent*, means 5 times A point;
- B = the number of *very good*, means 4 times B point;
- C = the number of *good*, means 3 times C point;
- D = the number of *not good*, means 2 times D point;
- E = the number of *awful*, means 1 times E point.

Other analyses are achieved as follows:

- Grading of living education: this item focuses on the cleanliness of the classroom. A perfect score is ten points, with the deduction of 0.5 point for every absence.
- Status of the attendance of lunch briefing of instructors: one instructor lunch briefing biweekly. A perfect score is eight points, with the deduction of 1 point for every absence.
- Grading by the departmental directors. A perfect score is 15 points, which is graded in accordance with the effect of the instructor in assisting students' lives.

Table 1: Items and scores in the evaluation of teachers who are assessed as having good performance.

Evaluation Item and Examining Unit	Full Score
Attendance at every meeting (living assistance group)	10 points
Teaching time and class meeting tutoring (extra-curricular activities group and assistance centre)	10 points
Student affection points (living assistance group)	12 points
Grading of living education (living assistance group and hygiene group)	15 points
Status of attendance at lunch briefings of instructors (extracurricular activities group)	8 points
Grading by departmental directors (every departmental director)	15 points

The Working Method

A comparison of the points of the 20 teachers' evaluations is listed in Table 2. The weighting using the grey entropy method is identified and shown in Table 3. The results and rankings of the 20 teachers' evaluations are shown in Table 4.

THE GREY ENTROPY TOOLBOX VIA *MATLAB*

The input/output interface of the toolbox is based on the *Matlab* structure and, according to the characteristics of *Matlab*, the input data can be expanded infinitely to make this toolbox more powerful. In grey entropy, no matter how huge the rank is, the operational processing will not be influenced. Hence, it is known that the main purpose is not only the modification for the user, but also to make the results of the analysis system more convincing and practical.

The Operation of the Grey Entropy Toolbox

The basic requirements are as follows:

- Windows 2000 or upgrade version;
- *Matlab* 5.3 or upgrade version.

The instruction in *Matlab* is as follows:

- Key in: greyentropy (Enter):
- Input data: input=: $[a_1, b_1, c_1, d_1, \dots; a_2, b_2, c_2, d_2, \dots; \dots; a_n, b_n, c_n, d_n, \dots]$
 where: $[a_1, b_1, c_1, d_1, \dots; a_2, b_2, c_2, d_2, \dots; \dots; a_n, b_n, c_n, d_n, \dots]$: Inspected data.
- Click *Enter* and get the answer.

Matlab can display the values of D_k , k , e_k (including the processing of each factor), E, λ_k , the sum of weighting and β_k .

Table 2: Comparison points of the 20 teacher's evaluations.

Item and number	No:1	No:2	No:3	No:4
1.Each meeting attendance	9.5	9.0	10.0	8.5
2.Teaching time and class meeting tutoring	10.0	7.5	9.5	9.0
3.Points of student affection	10.32	9.44	9.57	9.30
4.Living education	12.34	12.52	10.16	11.54
5.Attendance of lunch briefing of teachers	7	8	7	6
Item and number	No:5	No:6	No:7	No:8
1.Each meeting attendance	6.0	8.5	10.0	9.0
2.Teaching time and class meeting tutoring	8.5	9.0	9.5	7.5
3.Points of student affection	10.60	10.47	9.10	8.80
4.Living education	12.39	13.23	11.57	9.87
5.Attendance of lunch briefing of teachers	8	7	6	8
Item and number	No:9	No:10	No:11	No:12
1.Each meeting attendance	9.5	9.0	9.5	7.0
2.Teaching time and class meeting tutoring	8.5	8.0	9.0	9.5
3.Points of student affection	7.44	8.53	9.40	8.80
4.Living education	12.53	13.58	12.80	12.60
5.Attendance of lunch briefing of teachers	6	6	8	6
Item and number	No:13	No:14	No:15	No:16
1.Each meeting attendance	10.0	8.5	8.0	8.5
2.Teaching time and class meeting tutoring	9.5	8.5	8.0	8.5
3.Points of student affection	9.62	8.62	8.80	10.56
4.Living education	11.14	10.13	13.25	14.13
5.Attendance of lunch briefing of teachers	7	8	6	7
Item and number	No:17	No:18	No:19	No:20
1.Each meeting attendance	8.0	8.0	8.6	9.0
2.Teaching time and class meeting tutoring	7.5	8.5	8.0	8.0
3.Points of student affection	11.79	10.49	10.24	10.71
4.Living education	12.79	11.49	12.24	11.71
5.Attendance of lunch briefing of teachers	7	8	7	6

Table 3: The data for each step.

No.	No:1	No:2	No:3	No:4	No:5	No:6	No:7
D_k	63.16	59.56	60.73	57.34	60.49	59.20	62.17
e_k	0.1693	0.1687	0.1687	0.1690	0.1694	0.1690	0.1686
λ_k	0.04997	0.05001	0.05001	0.04999	0.04997	0.04999	0.05001
No.	No:8	No:9	No:10	No:11	No:12	No:13	No:14
D_k	58.17	54.47	55.61	61.70	57.90	60.26	5.75
e_k	0.1692	0.1685	0.1684	0.1692	0.1673	0.1692	0.1696
λ_k	0.04998	0.05002	0.05002	0.04998	0.05009	0.04997	0.04995
No.	No:15	No:16	No:17	No:18	No:19	No:20	
D_k	56.55	59.19	59.08	57.98	60.08	58.42	
k	0.0772	0.0772	0.0772	0.0772	0.0772	0.0772	
e_k	0.1677	0.1685	0.1683	0.1689	0.1690	0.1696	
λ_k	0.05007	0.05002	0.05003	0.04999	0.04999	0.04995	

*where: $k=0.0772$, $E=3.3761$

The outputs of the grey entropy toolbox are shown in Figures 2-4. The others function are as same as in Windows (ie *copy*, *cut*, *paste* and *exit*).

Table 4: The results of the 20 teachers' evaluations.

Number	Weighting	Rank	Number	Weighting	Rank
No:1	0.049970	17	No:11	0.049978	14
No:2	0.050007	8	No:12	0.050092	1
No:3	0.050007	8	No:13	0.049974	16
No:4	0.049986	13	No:14	0.049951	20
No:5	0.049965	18	No:15	0.050067	2
No:6	0.049988	12	No:16	0.050018	6
No:7	0.050011	7	No:17	0.050031	3
No:8	0.049975	15	No:18	0.049994	10
No:9	0.050020	5	No:19	0.049990	11
No:10	0.050024	4	No:20	0.049953	19

CONCLUSIONS

Matlab is very convenient and practical for engineering researchers. It is easily operated due to its wide coverage, assembly-based language and simple algorithms. It is possible for users to develop their own calculation functions and integrate them into the toolbox; this greatly enhances *Matlab*'s functions. Also, *Matlab* has many other toolboxes for convenient operation with specific calculations for users of different application domains. As such, if the grey entropy toolbox can be designed by combining the advantages of *Matlab*, then the research problems of grey entropy can be solved with ease. It will be also convenient to develop related software with *Matlab* as the core.

However, given the current analysis, a quantitative formula is particularly needed to meet practical needs. Grey entropy helps in this regard, and this article makes some contributions. Furthermore, teacher appraisals is a current trend in the educational field, which has often used traditional methods of analysis, and has failed to gain great recognition. However, with the current emphasis on education, constructing an appropriate system for teacher evaluations can raise teacher quality and is an important factor in ensuring the effects of education reform.

From the results shown in Table 3, decision-makers can screen the required quota of the teaching faculty in accordance with their needs, usually by selecting the top 10 percentage teachers with good performance. As a result, it not only accomplishes the effect of comparison but also possesses a motivational effect. The result can be said to be relatively reasonable. However, if the result is still not satisfactory, then methods from other fields can be used, which will treat the course of analysis as dynamic and reanalyse the result. Consequently, this will make the decision of decision-makers more convincing.

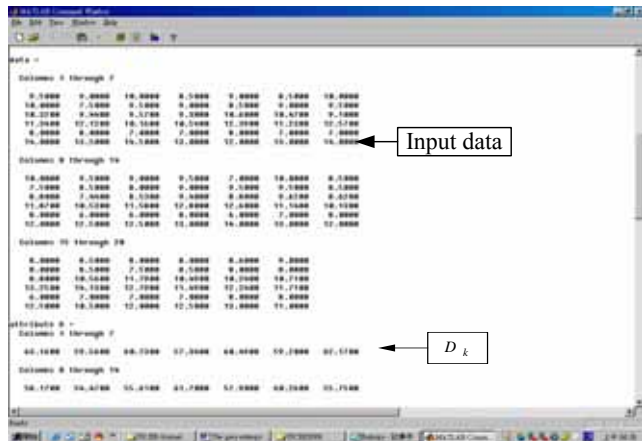


Figure 2: Input of data.

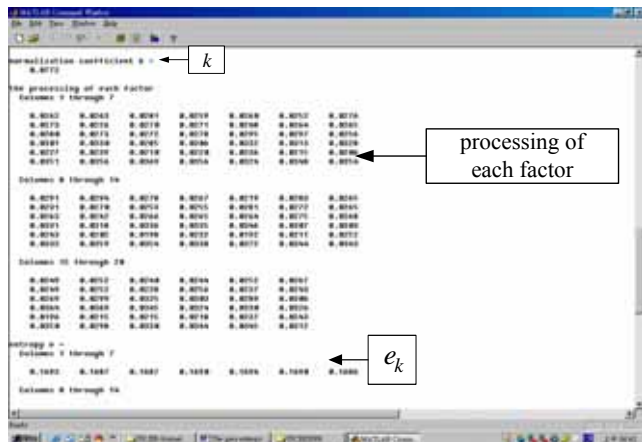


Figure 3: The processing of execution results-1.

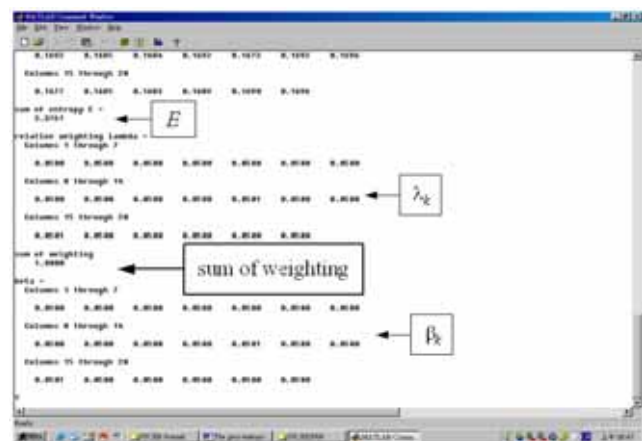


Figure 4: The processing of execution results-2.

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