Journal of Mathematics Research
http://ccsenet.org/jmr
Vol. 2, No. 1
February 2010

Teaching Effect Assessment Method of Basis Courses in Engineering Institutions Based on Homogeneous Markov Chain

Yucai Dong (Corresponding author)
Institute of Nonlinear Science, Academy of Armored Force Engineering
Beijing 100072, China

Weidong Li
Institute of Department of Science Research, Academy of Armored Force Engineering
Beijing 100072, China

Hongtao Shi, Ling Zhang, Lianghai Yi, Hongyan Li & Guojun Sun
Institute of Nonlinear Science, Academy of Armored Force Engineering
Beijing 100072, China
E-mail: steven-shihongtao@qq.com

Abstract

Using Markov chain model and by the changes of state transition about system, this paper describes the dynamic characteristics of teaching method of the basis course in the engineering institutions, which reflects the management of institutions and effect of teaching and learning.

Keywords: Homogeneous Markov chain, Public courses, Teaching assessment, Transition matrix

1. Introduction

Real, comprehensive, accurate assessment of the project based on teaching effectiveness of institutions can promote the improvement of teaching quality and has important role in high-quality talent. Teaching quality assessment is a complex dynamic system engineering, and teaching method of assessment should be determined by the nature and characteristics of teaching. A suitable teaching assessment method and model suit for all schools does not exist; Teacher's participation is the basic condition for implementing any method of teaching assessment, and also is the security for achieving goal of teaching evaluation ; The goal of any teaching assessment method or model use is only one, i.e. improve the teaching, improve large-area fully quality of teaching and train talents.

Many colleges have carried teaching assessment. Practices have proved that classroom teaching assessment is an important mean for feedback the teaching information, which can help teachers and students to effectively monitor the classroom instruction and classroom learning process, improve the quality of teaching and promote self-improvement of teachers. However, for some reasons, in practice the current traditional method based solely on student's average performance, variance and teacher evaluating students's learning attitude to assess the quality of teaching is one-sided and inaccurate. Because the test scores of students depend on many factors, where the basis difference of students is a very important factor. Many colleges exist many problems of teaching assessment, which have a certain negative effect on teaching and learning activities.

Homogeneous Markov chain analysis is a statistical method based on probability and using mathematical models to analyze the number development and changes in the process of object relations. Homogeneous Markov chain is widely used in the forecast stock prices, business unit forecast of human resource flows, the RMB exchange rate forecast, as well as a variety of market forecast. Zhenhua Ma, in literature (Zhenhua Ma, 2002) , researched Markov chain theory and applications. Xiangyang Cheng, in literature (Xiangyang Cheng, 2007), using the properties of homogeneous Markov chain, analysis the models of structure of school talents to carry out modeling analysis.

2. Principle of Homogeneous Markov Chain

In a random process, if the probability of a state transition from one state to another only has anything to do with the current state, but has nothing with the state before this moment, which is known as Markov process. Markov chain is a Markov process for discrete state and time , referred to Markov chain. According to the composition of Markov chain, the process has the following three characteristics:

(1) Discreteness of process. The development of system can be separated into limited states in time.

(2) Stochastic process. The system from one state to another state is a random, and transition is valued by the probability of original history conditions.

(3) Process without aftereffect. The transition probability of system only is with the current state, and has nothing to do with the previous state. That is, the ith result of certain elements of a system only influenced by the $(i-1)$th result in the transition, and has nothing to do with other results.

A random process $\{X_n, n = 0, 1, 2\cdots\}$ is a set of random variables and X_n can take various different values, which is known as the state. If the transition probability of a random process $\{X_n, n = 0, 1, 2\cdots\}$ from one state to another state only is with the current state and has nothing with the state before this moment. That is, if the conditional probability distribution of X_{n+1} in the process $\{X_n, n = 0, 1, 2\cdots\}$ is only dependent on the value of X_n, and independent of the prevenient value, whose process is called Markov process. Markov chain is a Markov process about discrete time and discrete state. If a Markov chain transfers from the state i in u moment to state j in $t + u$ moment, its probability has nothing to do with the starting time u, which is known as the homogeneous Markov chain. If denoting transition probability from state i to state j by P_{ij}, $P_{ij} = P\{X_{n+1} = j|X_n = i\}, i, j = 0, 1, 2\cdots$ and transition probability matrix is P. So that a homogeneous Markov chain is completely determined by a transition probability matrix P and the probability distribution in zero time $x = 0, 1, 2\cdots$. By the properties of homogeneous Markov chain, A_i in the ith state and A_{i+1} in the $(i + 1)$th state have relationships: $A_{i+1} = A_iP$.

In the quantitative indicators of teaching effectiveness for basic courses in engineering institutions, homogeneous Markov chain takes the ratio of each grade student number than the total number as state variable, where those grades are excellent (hyper-90 points), good (80-89 points), medium (70-79 points), passed (60-69 points) and failed (under 59 points) groups in a certain test, denoted by vector $P(t) = (X_1(t), X_2(t), X_3(t), X_4(t), X_5(t))$, where t is moment, $t \in N$. Because homogeneous Markov chain has nothing to do with the state before moment t(without aftereffect), we can study the change rule of state vector when t changes, which can effect physical education and quality evaluation. Suppose in the first examination, excellent, good, medium, passed and failed students of n students in a class are $n_i(i = 1, 2, 3, 4, 5)$, the state vector $P(1) = (n_1/n, n_2/n, n_3/n, n_4/n, n_5/n)$ is called initial vector. To study the teaching quality , we continue to analysis level changes of the above students in the next examination. If in the second test, the number of original n_1 excellent students maintained still excellent is n_{11} and students transforming to "good", "medium", "passed", "failed" students are $n_{12}, n_{13}, n_{14}, n_{15}$. So the examination transition condition for the first excellent students is

$$P_1 = (\frac{n_{11}}{n_1}, \frac{n_{12}}{n_1}, \frac{n_{13}}{n_1}, \frac{n_{14}}{n_1}, \frac{n_{15}}{n_1}).$$

Similarly, the rest examination transition condition for the rest grade students are

$$P_2 = (\frac{n_{21}}{n_2}, \frac{n_{22}}{n_2}, \frac{n_{23}}{n_2}, \frac{n_{24}}{n_2}, \frac{n_{25}}{n_2}),$$

$$P_3 = (\frac{n_{31}}{n_3}, \frac{n_{32}}{n_3}, \frac{n_{33}}{n_3}, \frac{n_{34}}{n_3}, \frac{n_{35}}{n_3}),$$

$$P_4 = (\frac{n_{41}}{n_4}, \frac{n_{42}}{n_4}, \frac{n_{43}}{n_4}, \frac{n_{44}}{n_4}, \frac{n_{45}}{n_4}).$$

Where $n_{ij}(i, j = 1, 2, 3, 4, 5)$ denote the number from state i to state j. The transition case is expressed as a matrix:

$$P = \begin{bmatrix} \frac{n_{11}}{n_1} & \frac{n_{12}}{n_1} & \frac{n_{13}}{n_1} & \frac{n_{14}}{n_1} & \frac{n_{15}}{n_1} \\ \frac{n_{21}}{n_2} & \frac{n_{22}}{n_2} & \frac{n_{23}}{n_2} & \frac{n_{24}}{n_2} & \frac{n_{25}}{n_2} \\ \frac{n_{31}}{n_3} & \frac{n_{32}}{n_3} & \frac{n_{33}}{n_3} & \frac{n_{34}}{n_3} & \frac{n_{35}}{n_3} \\ \frac{n_{41}}{n_4} & \frac{n_{42}}{n_4} & \frac{n_{43}}{n_4} & \frac{n_{44}}{n_4} & \frac{n_{45}}{n_4} \\ \frac{n_{51}}{n_5} & \frac{n_{52}}{n_54} & \frac{n_{53}}{n_5} & \frac{n_{54}}{n_5} & \frac{n_{55}}{n_5} \end{bmatrix} = (p_{i,j}).$$

P is a transition probability matrix. Student achievements according to state transition probability matrix of Homogeneous Markov chain is bound to more stable. $X = (x_1, x_2, x_3, x_4, x_5)$ has non-impact, and influencing the student achievement is the teaching and learning process from the first examination to the second examination, as well as the change condition P according to this process. Through the transition probability matrix of student's learning state, we can predict ultimately the steady state of a class of students. For teachers, it can be used to evaluate and predict the quality of teaching class. If giving different scores to different levels in the end, we can get a comprehensive evaluation result of teaching and learning performance.

3. Application Examples

Select two "Advanced Mathematics" courses of seven classes to assess the results. The examination transition vectors of all students computed by contrasting two scores are as follows:

$$P_1 = (0 \quad 1.0000 \quad 0 \quad 0 \quad 0),$$

$$P_2 = (0.1000 \quad 0.1000 \quad 0.8000 \quad 0 \quad 0)$$

$$P_3 = (0.0385 \quad 0.3077 \quad 0.2692 \quad 0.2692 \quad 0.1154)$$

$$P_4 = (0 \quad 0 \quad 0.2308 \quad 0.4615 \quad 0.3077)$$

$$P_5 = (0 \quad 0.0192 \quad 0.0769 \quad 0.1731 \quad 0.7308)$$

Then the transition matrix is as follows:

$$P = \begin{bmatrix} 0 & 1.0000 & 0 & 0 & 0 \\ 0.1000 & 0.1000 & 0.8000 & 0 & 0 \\ 0.0385 & 0.3077 & 0.2692 & 0.2692 & 0.1154 \\ 0 & 0 & 0.2308 & 0.4615 & 0.3077 \\ 0 & 0.0192 & 0.0769 & 0.1731 & 0.7308 \end{bmatrix}.$$

The limit vector of this transition matrix is

$$x = (0.0206 \quad 0.1136 \quad 0.2413 \quad 0.2432 \quad 0.3813).$$

Analysis results for the examination of every learning class can be seen in Table 1, Figure 1 and Table 2.

From the examples, we can see that the ranking changes using homogeneous Markov chain assessment instead of traditional methods. We may know that the second class ranking is unchanged and it ranks first now, which explains that the second class has not only good basis , but also the largest progress. The third, forth and seventh classes improve ranking, which is known that it has a relatively larger progress. The first, fifth and sixth is opposite.

4. Conclusions

Homogeneous Markov chain approach can be sensitive to reflect the true effect of teaching. Traditional teaching approach is based on student's scores of a particular distortion, only taking into account achievements of students, which results the assessment. The analysis result of homogeneous Markov chain is only concerned with the transition matrix, and has nothing to do with one examination result of students, which is assessed according to the transition state of two examinations. The good or bad effect of teaching is reflected by the rise or decline of students scores, which reflects superiority and objectivity of Markov chain theory. Researching the teaching method is the basic subject, and also is the eternal subject. Only pursuing high-quality effect and high standard teaching effect for teachers can truly embody the diathesis education and the forever value of quality education, find out assessment method suit for basis courses in colleges, and train high-quality talents.

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Table 1. Examination Analysis

	the first examination		the second examination	
teaching class	average score	ranking	average score	ranking
one	74.08	3	75.63	2
two	79.63	1	82.45	1
three	78.87	2	73.80	5
four	72.44	5	75.13	3
five	73.53	4	74.40	4
six	69.10	6	65.25	6
seven	63.51	7	60.92	7

Table 2. Comprehensive Evaluation

teaching class	limiting vector	score	ranking
one	(0.1404 0.4496 0.2817 0.0514 0.0769)	78.33	4
two	(0.3351 0.4759 0.1457 0.0320 0.0112)	85.63	1
three	(0.2811 0.3855 0.2239 0.0849 0.0246)	82.52	3
four	(0.2810 0.4277 0.1896 0.0638 0.0378)	82.55	2
five	(0.1882 0.2426 0.2210 0.2098 0.1384)	72.86	5
six	(0.0111 0.0785 0.1587 0.3239 0.4278)	53.52	7
seven	(0.0206 0.1136 0.2413 0.2432 0.3813)	56.96	6

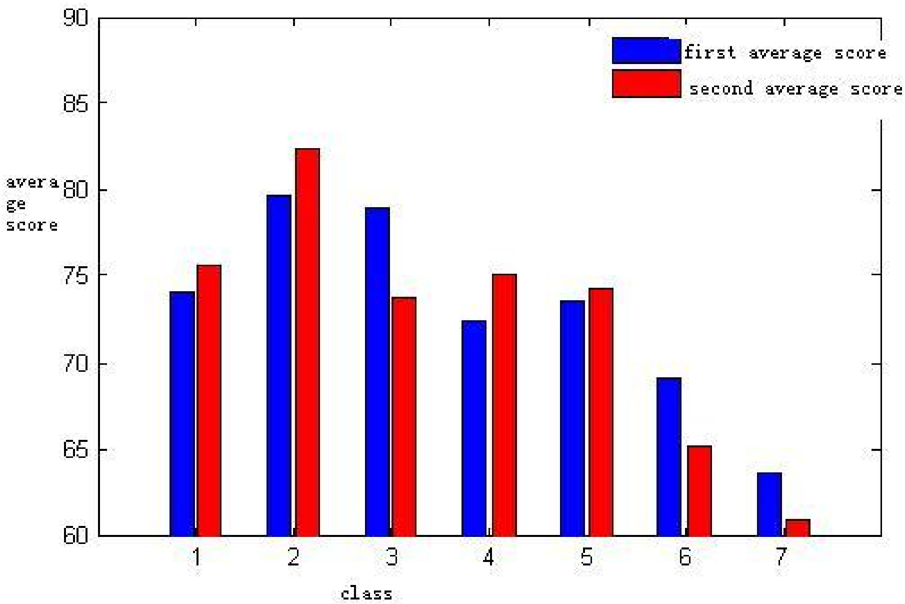

Figure 1. Average scores comparison of classes