A study of the construction of teaching staff of He Nan private universities

Jun Zhang

School of Foreign Languages, Huanghe S. & T.College, Zhengzhou, 450063, China

Corresponding author's e-mail: zhangjunhust@yeah.net

Received 1 October 2013, www.cmnt.lv

Abstract

Under the strong promotion of "Twelfth Five Year Plan", more and more attention is paid to private colleges from higher education of our country. With the further development of private universities, teaching staff of private universities is becoming a top priority of its development process. Based on the analysing the current situation of private colleges faculty construction in Henan, this paper introduces the mathematical principles of Markov analysis model and its basic forecasting steps. Then this paper establishes an application example of Teaching Staff planning utilizing Excel, carrying out the quantity plan and classification plan. At last, this paper analysis the result of planning results.

Keywords: private college, teaching staff, Markov analysis model

1 Introduction

The accelerating of popularization of higher education promotes the development of private education. Henan has the largest number of students in China, so private colleges get rapid development. At present there are many problems in Henan private colleges: insufficient number of teachers, irrational structure of teaching staff, lack of double-qualified teachers, poor average quality of teachers, lack of training, etc. Thus developing a scientific and rational teaching staff plan is the foundation of establishing a stable, high-quality teaching staff team, also is the guaranteeing promoting the sustainable healthy development of private education colleges in Henan.

At present the formulating of University Teaching Staff planning is focuses on aspects of policy formulation and implementation of measures mostly in Henan. Most teacher supply and demand forecasts depend on subjective speculation, or is limited to the reference of educational assessment index quantify, not based on the actual situation of universities, not considered the internal development law and stage of development objectives of the strategy, leading that university for the future supply of teachers in the number and structure is difficult to grasp.

2 The content and methods of university teaching staff planning

The content of university teaching staff planning includes quantity plan and classification plan. The quantity plan is decided by the scale of development in the number of students as one of the main parameters, quantitative calculated by the student-teacher ratio.

The classification plan is based on the university Teaching Staff status. It will combine with the overall development strategy, considering internal and external factors, to carry on the quantitative calculation including title structure, educational structure, age structure, professional structure. Thus we can formulate scientific and rational Teaching Staff building regulations, such as talents plan, job promotion plan, teacher training plan, professional teachers construction division, and so on [1].

In the college Teaching Staff planning, the main task is predicting the number, structure and other properties of future teachers each year by the changes in the structure and number of teaching staff. So we choice the Markov analysis model to be the model of quantitative calculating.

The Markov analysis model is one of prediction models named by Russian mathematician Markov. It uses time series as stochastic process, determine the status of trends and predict the future state of things by calculating initial probability and studying state transition probabilities.

The basic forecast steps of Markov analysis model is as follows:

1) At time *t*, system *S* has n independent states, and its probability vector of initial state is:

$$S(0)=\left[S_1(0),\quad S_2(0),\quad \ldots\quad S_n(0)\right]. \tag{1}$$

2) At time t_{i+1}, the probability of system $A_i \to A_j$ is just related to time t_i, nothing to do with the time before t_i. Taking statistical estimates or subjective estimation, all the state transition probabilities is in order to line up. The state transition probability matrix is:

$$P=\begin{bmatrix} P_{11} & P_{12} & .. & P_{1N} \\ P_{21} & P_{22} & .. & P_{2N} \\ .. & .. & .. & .. \\ P_{N1} & P_{N2} & .. & P_{NN} \end{bmatrix}. \tag{2}$$

3) The Markov chain has the property of no after effect. After k times transfer, system S's state probability is:

$$S^{(k)}=S^{(k-1)}\cdot P$$

and recursive to get [2]:

$$S^{(k)} = S^{(0)} \cdot P^{(k)}. \quad (3)$$

The weighted mean value $g_{i,j}$ of the pixel values in $W'_{i,j}$ is defined as:

$$g_{i,j} = \frac{\sum_{f_{i+s,j+t} \in W'_{i,j}} w_{i+s,j+t} f'_{i+s,j+t}}{\sum_{f_{i+s,j+t} \in W'_{i,j}} w_{i+s,j+t}}, \quad (4)$$

where $w_{i+s,j+t}$ means the weight of $f'_{i+s,j+t}$. Let $m'_{i,j}$ be the median value of $W'_{i,j}$. Because the median value has the least probability to be the value of the corrupted pixels [3], $m'_{i,j}$ is utilized to determine $w_{i+s,j+t}$. It is easy to understand that the smaller the absolute difference between $f'_{i+s,j+t}$ and $m'_{i,j}$, the larger the weight $w_{i+s,j+t}$ should be to strengthen the influence of $f'_{i+s,j+t}$ on $g_{i,j}$. Based on extensive simulations which indicate that $w_{i+s,j+t}$ is dependant on both above absolute difference and noise ratio, $w_{i+s,j+t}$ is chosen as:

$$w_{i+s,j+t} = \frac{R}{R + (1-R)\sqrt{1 - \dfrac{|f'_{i+s,j+t} - m'_{i,j}|}{f'_{\max} - f'_{\min}}}} \quad (5)$$

where $f'_{\max}$ and $f'_{\min}$ denote the maximum pixel value and the minimum one in the noise image, respectively.

3 The examples of application

It is supposed that a university in Henan has 6000 students. With the great development of the school and then enhance of overall competitiveness, this university plans to expand the size of school, and the number of students will increase by the proportion 8%. After five years the total students will reach to the quantity of 8800.

According to the excellent rating requirements (the student-teacher ratio is 16:1), we can calculate the total demand for teachers. Now we start Excel, create tables; edit formulas to calculate the total number of students and teachers demand. We input "=B2*1.08" to C2 cell, fill the formula to D2:G2 cell; input "=B3/16" to B4 cell, and fill the formula to C2:G4 cell too. The result is in Table 2.

Table 1 shows the teacher title structure at present. It is assumed that this school plans to introduce 60 teachers each year. We can get that titles is compositing of no title, junior, intermediate, deputy high and senior from Figure 1. What's more it also includes new teachers, retirement and transfer which can affect title structure changes. So each title talent early ownership (Probability vector of the initial state of prediction system) S0 = [60, 16, 96, 180, 158, 15, 0].

Analysis of teacher mobility and job promotion case, job promotion and transfer of all types can be seen in Table 3.

TABLE 1 The teacher title structure at present

Title	Sum	Senior	Deputy high	Intermediate	Junior	No title
Number	465	15	158	180	96	16
Percentage (%)	100	3.2	34.0	38.7	20.6	3.4

TABLE 2 The planning of total demand for teachers

Item	Present	The first year	The second year	The third year	The fouth year	The fifth year
Students number	6000	6480	6998	7558	8163	8816
The total demand for teachers	375	405	437	472	510	551

TABLE 3 Job promotion and transfer of all types

Title	New teachers	No title	Junior	Intermediate	Deputy high	Senior	Retirement and transfer
New teachers	0	5%	30%	60%	5%	0	0
No title	0	20%	75%	0	0	0	5%
Junior	0	0	58%	30%	0	0	12%
Intermediate	0	0	0	75%	15%	0	10%
Deputy high	0	0	0	0	89%	5%	6%
Senior	0	0	0	0	0	93%	7%
Retirement and transfer	0	0	0	0	0	0	1

In Table 3, each row represents the percentage of current title retention and promotion for other titles. Each column represents the percentage of all types of title retention and increase and getting the state transition matrix of titles by Equation:

$$P=\begin{bmatrix} 0 & 5\% & 30\% & 60\% & 5\% & 0 & 0 \\ 0 & 20\% & 75\% & 0 & 0 & 0 & 5\% \\ 0 & 0 & 58\% & 30\% & 0 & 0 & 12\% \\ 0 & 0 & 0 & 75\% & 15\% & 0 & 10\% \\ 0 & 0 & 0 & 0 & 89\% & 5\% & 6\% \\ 0 & 0 & 0 & 0 & 0 & 93\% & 7\% \\ 0 & 0 & 0 & 0 & 0 & 0 & 1\% \end{bmatrix}. \quad (6)$$

It can be getting the number of all types of titles of the first year by Equation:

$$S_1 = S_0 \cdot P$$

$$= \begin{bmatrix} 60, & 16, & 96, & 180, & 158, & 15, & 0 \end{bmatrix}$$

$$\cdot \begin{bmatrix} 0 & 5\% & 30\% & 60\% & 5\% & 0 & 0 \\ 0 & 20\% & 75\% & 0 & 0 & 0 & 5\% \\ 0 & 0 & 58\% & 30\% & 0 & 0 & 12\% \\ 0 & 0 & 0 & 75\% & 15\% & 0 & 10\% \\ 0 & 0 & 0 & 0 & 89\% & 5\% & 6\% \\ 0 & 0 & 0 & 0 & 0 & 93\% & 7\% \\ 0 & 0 & 0 & 0 & 0 & 0 & 1\% \end{bmatrix}$$

Similarly we can get the number of all types of titles of the second-fifth year.

$$S_2 = S_0 \cdot P^{(2)} = S_1 \cdot P, \quad (7)$$

$$S_3 = S_0 \cdot P^{(3)} = S_1 \cdot P^{(2)} = S_2 \cdot P, \quad (8)$$

$$S_4 = S_0 \cdot P^{(4)} = S_1 \cdot P^{(3)} = S_2 \cdot P^{(2)} = S_3 \cdot P, \quad (9)$$

$$S_5 = S_0 \cdot P^{(5)} = S_1 \cdot P^{(4)} = S_2 \cdot P^{(3)} = S_3 \cdot P^{(2)} = S_4 \cdot P \quad (10)$$

Start excel and create table "Teaching staff classification plan (by title) table". By Equation (4), put each element of transition matrix to B4:B10 cells, and put the initial number of teachers of each title to I4:I10 cells. Input formula "SUM (I5:I9)" at I10 cell, just like Figure 1.

We can use SUMPRODUCT function to calculate the annual number of teachers. SUMPRODUCT is the function that multiplied by the corresponding element in the array and summing operation. It can be used to solve step transition matrix vector. Its basic format is

SUM PRODUCT (arrav1, arrav2, arrav3…).Input these at J4~J10 cells:

J4: "= SUMPRODUCT(I4:I10,B4:B10)"
J5: "= SUMPRODUCT(I4:I10,C4:C10)"
J6: "= SUMPRODUCT(I4:I10,D4:D10)"
J7: "= SUMPRODUCT(I4:I10,E4:E10)"
J8: "= SUMPRODUCT(I4:I10,F4:F10)"
J9: "= SUMPRODUCT(I4:I10,G4:G10)"
J10: "= SUMPRODUCT(I4:I10,H4:H10)"

We can calculate the number of teachers in the first year of planning S1 = [0, 3, 122, 180, 162, 23, 36]. Then input "=SUM (J9)" at J11 cell, get the total teacher number in the first year is 485.

Similarly we can get the number of all types of titles of the second-fifth year, and the result is as Figure 2 shows.

Teaching staff classification plan (by title) table

Title	transition matrix P							The planning of teachers each year					
	new teachers	no title	junior	intermediate	deputy high	senior	retirement and transfer	Present	The first year	The second year	The third year	The fouth year	The fifth year
new teachers	0	5%	30%	60%	5%	0	0	60					
no title	0	20%	75%	0	0	0	5%	16					
junior	0	0	58	30%	0	0	12%	96					
intermediate	0	0	0	75%	15%	0	10%	180					
deputy high	0	0	0	0	89%	5%	6%	158					
senior	0	0	0	0	0	93%	7%	15					
retirement and transfer	0	0	0	0	0	0	1	0					
The total teachers number of each year								465					

FIGURE 1 Teaching staff classification plan (by title) table

Teaching staff classification plan (by title) table

Title	transition matrix P							The planning of teachers each year					
	new teachers	no title	junior	intermediate	deputy high	senior	retirement and transfer	Present	The first year	The second year	The third year	The fouth year	The fifth year
new teachers	0	5%	30%	60%	5%	0	0	60	60	60	60	60	0
no title	0	20%	75%	0	0	0	5%	16	6	4	4	4	4
junior	0	0	58	30%	0	0	12%	96	86	72	63	58	54
intermediate	0	0	0	75%	15%	0	10%	180	200	212	216	217	216
deputy high	0	0	0	0	89%	5%	6%	158	171	185	199	213	226
senior	0	0	0	0	0	93%	7%	15	22	29	36	44	51
retirement and transfer	0	0	0	0	0	0	1	0	41	42	43	44	45
The total teachers number of each year								465	484	502	519	536	550

FIGURE 2 Teaching staff classification plan (by title) table

The thing should pay attenuation not is that, Introduction of the new teacher data is corrected to 60 in the calculation process, then edit formula calculating the number of retired or transferred, and subtracting the number of the previous year of retirement or reassignment on the basis of the calculation result [4-6].

4 Experimental results

The total demand for teachers.

Making contrast with the total demand and the total number of teachers each year in the Figure 1 and Figure 2, we can get Figure 3.

The total demand for teachers and result analysis

Itme	Present	The first year	The second year	The third year	The fouth year	The fifth year
students number	6000	6480	6998	7558	8163	8816
The total demand for teachers	375	405	437	472	510	551
planning number	465	484	502	519	536	550
planning stud-teac ratio	12.9	13.4	13.9	14.6	15.2	16

FIGURE 3 The total demand for teachers

We can get from Figure 3 that the total number of teachers each year is bigger that total demand based on Markov analysis model planning. In the fifth years both are basically the same data. Quantify the planning process from the current situation teaching staff, and consider the mobility and job promotion and other factors [7, 8].

Ownership of teachers.

Ownership of teachers is that in the introduction of the New Year to keep teachers in 60 conditions the same premise, the number of models based on Markov analysis of various types of titles planned for each year teachers, as showed in Figure 2.

From Figure 3 we could know that the teachers with a positive senior and senior title number year by year growth trend in the 5 years. By formula" (I8+ I9) / I11", its proportion was 37 percent early. By formula" (N 8+ N 9)/ I11", its proportion was up to 50 percent in the fifth year. By formula N 6/ N 11, N 7/ N 11, N 8/ N 11, N 9/ N 11, percentage of each title is 10%, 39%, 41%, and 9% in the fifth year. So the result shows that teaching staff title structure is more reasonable, the overall level has increased [9].

5 Conclusions

Application examples use computer office software achieved a university Teaching Staff planning Markov model-based analysis. Title classification as an example, departure from the status quo, considering the various internal and external factors, through qualitative and quantitative analysis, realized the planning of the total demand for teachers and classification ownership. Data is scientific, objective, operability and controllability. The proposed method is easy to understand. Designed form is simple generic. Conducting analysis of other categories of planning, decision-making, simply modify the parameters of the table, you can get information on decision making, has a certain value.

References

[1] Asmussen S 2003 Applied Probability and Queues 51 2nd edition *Springer-Verlag, New York* 142-7

[2] Asmussen S, Avram F, Pistorius M R 2004 Russian and American put options under exponential phase-type Lévy models *Stochastic Process Appl* 109 79–111

[3] Babillot M 1988 Théorie du renouvellement pour des chaînes semi-markoviennes transientes *Ann. Inst. H. Poincaré Probab. Statist* 24 507-69

[4] Benveniste A, Jacod J 2013 Systèmes de Lévy des processus de Markov *Invent. Math* 21 183-98

[5] Bergh J, Löfström J 1976 Interpolation Spaces An Introduction *Springer-Verlag, Berlin* 79-111

[6] Bhattacharya R N 1982 On the functional central limit theorem and the law of the iterated logarithm for Markov processes *Probab Theory Related Fields* 60 185-201

[7] Billingsley P 1995 Probability and Measure *3rd edition John Wiley & Sons Inc New York*

[8] Bladt M, Meini B, Neuts M F, Sericola B 2002 Distributions of reward functions on continuous-time Markov chains *Matrix-Analytic Methods World Sci. Publishing, Adelaide* 39-62

[9] Bradley R C 2005 Basic properties of strong mixing conditions a survey and some open questions *Probab. Surv* 107-44

Author

Zhang Jun, born in 1976, Xinyang, Henan, China.

Current position, grades: associate professor, postgraduate.
University studies: MA degree in British and American Literature from Henan University.
Scientific interest: British and American Literature, English education.
Publications: 9 papers.