A RATING ALGORITHM IN UNIVERSITY MANAGEMENT

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Abstract

An objects rating and classification algorithm based on the methods of math statistics was suggested in this issue. This algorithm became the central point to create the rating (the so-called integral indicator) of Grodno State University departments for the period of two years (2004, 2005). Departments grouping was made according to the uniform value of the integral indicator. The choice of the number of groups was grounded. Analysis of variables, being of great importance to create the departments rating, was carried out.

1 Introduction

Annual departments rating, according to the effectiveness of their performance, is executed in Grodno University. And the so-called integral indicator is used to fulfill this rating. To create it, a number of variables, reflecting this or that department activity, are chosen. These variables are given weights. The sum of their products shows the value of the integral indicator. A group of experts is made to select these variables. The weights are chosen by the experts as well in accordance with the managerial tasks being solved.

In order to build the integral indicator methods of math statistics are suggested to be used thus reducing the experts decision influence. Such researches were carried out by the Central Economics and Mathematics Institute of Russian Academy of Sciences under the leadership of S.A. Aivazyan when creating the population living quality rating [1–3]. The value of the first principal factor was used as an integral indicator. If the first main factor keeps big per cent of the total variance of the initial variables, then one may consider it to be the satisfactory approximation of all the analyzed particular criteria. The research work [3, p. 16] suggested considering to be enough keeping not less than 55% of variance of the initial variables.

The similar method was used by the author when rating Grodno region territories to analyze small business for the period of 5 years (2000–2004) [4].

2 Chairs rating

Managerial objects rating has been created using the factor analysis, in particular the university departments rating. As it turned out, the first principal factor in this case keeps insufficient per cent of the total variance for approximation of all the initial

variables. That is why using m first principal factors is suggested. The number of the principal factors is selected in the following way. It should be, possibly, the least for better interpretation. All the initial variables must have the significant relation with the main factors.

Let $X_1, X_2, \ldots, X_p$ be the variables reflecting the departments performance, N_i — the quantity of the lectures of i-th department. To compare different departments performance the results were calculated per one staff lecturer. The variables X_i/N_i, $i = \overline{1,p}$, have been calculated using the method of the principal components. The integral indicator is proposed to be built on the basis of the values of m first factors, with the part of the variance being kept by each factor being suggested to be taken as a weight of this factor:

$$R = \Big(\sum_{i=1}^{p} \lambda_i\Big)^{-1} \big(\lambda_1 F_1 + \lambda_2 F_2 + \ldots + \lambda_m F_m\big), \tag{1}$$

F_i — the values of the principal factors, λ_i ($\lambda_1 \geq \lambda_2 \geq \ldots \geq \lambda_m$) — are eigenvalues of covariance matrix of the variables X_i/N_i, $i = \overline{1,p}$.

The analysis of the performance of sixty-seven departments of Grodno State University has been carried out for the period of 2 years (2004, 2005). 49 variables, offered by the University Management Center, were used. According to the 2004 year data the first principal factor keeps 15,51% of the total variance (table 1). This factor unites the following closely connected variables: the quantity of doctors, professors, candidates, readers, publications in foreign and republican journals, doctors dissertations and republican grants reviews (per one lecturer). It shows that the presented variables reflect the biggest difference among the departments. The second main factor keeps around 9% of the total variance. It includes three variables illustrating the membership in the election bodies at ministerial and republican levels, the participation in administrative activity, in other universities dissertation committees as well as governmental rewards.

	2004			2005		
Variable N	Eigenvalue	% of variance	Cumulative variance	Eigenvalue	% of variance	Cumulative variance
1	7,60	15,51	15,51	8,88	21,67	21,67
2	4,30	8,77	24,28	3,62	8,83	30,50
3	3,59	7,33	31,60	3,51	8,55	39,05
4	2,63	5,36	36,96	2,80	6,82	45,87
5	2,59	5,29	42,25	2,05	4,99	50,86
6	2,46	5,03	47,28	1,97	4,81	55,67
7	2,24	4,58	51,86	1,86	4,55	60,22
8	2,10	4,28	56,14	1,68	4,09	64,31
9	1,85	3,78	59,92	1,41	3,45	67,76
10	1,66	3,39	63,31	1,29	3,15	70,91

Table 1: Principal components method results

Ten principal factors keep 63.31% of the total variance (table 1), all the initial variables having significant relation with the factors built. For the given case the

equation (1) will be the following:

$$R = 0{,}155F_1 + 0{,}088F_2 + 0{,}073F_3 + 0{,}054F_4 + 0{,}053F_5 + \\ + 0{,}050F_6 + 0{,}046F_7 + 0{,}043F_8 + 0{,}038F_9 + 0{,}034F_{10}. \quad (2)$$

The values of the principal factors are centered with regard to zero. Therefore the indicator built is handy to be interpreted. In the given case R takes values from $-0{,}466$ up to 0,699 with the mean of $-3{,}33 \cdot 10^{-16}$. Thus the outstanding departments differ from intermediate ones much more than slow performers. 30 departments have positive values of the integral indicator and 36 departments have negative values (lower than average).

A 2005 year rating of the departments was made in the same way.

3 Chairs classification

Not only the departments rating is of interest but combination them into groups as well according to the uniform value of the integral indicator. All the departments were divided into groups using the k-means clustering. The number of groups was chosen to be as big as possible to get the significant difference of means in these groups. The division into 7 groups was obtained. Table 2 shows the means of the integral indicator in the groups and the quantity of departments in each group.

	2004		2005	
Cluster	Mean of R	Number of dep.	Mean of R	Number of dep.
1	0,606	4	1,518	1
2	0,316	6	0,319	10
3	0,087	11	0,054	19
4	−0,003	16	−0,070	19
5	−0,104	14	−0,186	13
6	−0,234	14	−0,334	4
7	−0,465	1	−0,656	1

Table 2: Integral indicator means in clusters

With the help of Scheffe test the significant difference of means in clusters is proved, comparing them in pairs ($p < 6 \cdot 10^{-5}$). The created integral indicator for the period of 2004 has a normal distribution. However, the size of some groups is small. That is why nonparametric methods were used as well to compare the integral indicator distribution in groups.

While grouping the departments according to 2005 year data the integral indicator values range proved to be much bigger (table 2). Besides, its distribution is not normal. When analyzing the initial variables, they were discovered to be not always true.

4 Conclusion

In accordance with 2004 data the third, the fourth and the fifth clusters contain 41 departments, with the values of the integral indicator being close to zero (mean). One

department has a very small value and is included into cluster 7. Four of the most successful departments are greatly distinguished from the rest ones (picture 1). The average rating value in the second cluster also differs greatly from the succeeding and the rest ones.

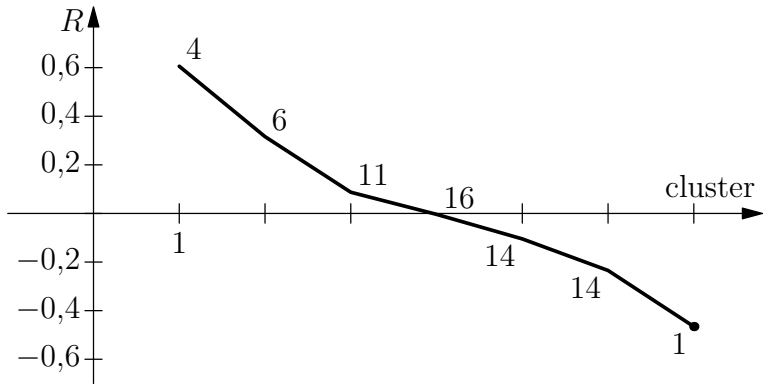

Figure 1: Integral indicator means in clusters

With the assistance of the analysis of variances the comparison of the means of the initial variables was executed (per one lecturer) in the created groups. Significant difference was found out for 22 variables ($p < 0{,}1$). We shall enumerate some of them: the number of candidates ($p < 9 \cdot 10^{-10}$), readers ($p < 4 \cdot 10^{-7}$), the quantity of republican grants ($p < 10^{-6}$), the number of post-graduate students ($p < 10^{-6}$), opposition to candidates dissertation ($p < 0{,}00005$), a number of lectures with doctor degrees ($p < 0{,}00006$) and professors ($p < 0{,}0004$).

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