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Performance Evalution Analysis for College Teachers Based on Weighted Ideal-point

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Abstract
The evaluation methods of college teachers' performance should be scientific and feasible. To accomplish this goal, we design the performance evaluation index system from three aspects as teaching, scientific research and professional disciplines development. By using the principal component analysis method we reduce the data dimension, through combining with the weighted ideal-point method, we get the final ranking result. Finally, an example is given to show the rationality and effect of the evaluation method.

Key words: College teachers; Performance evaluation method; Principal component analysis method; Weighted ideal-point method

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INTRODUCTION
Along with the development of our country high school personnel system reform, improving the enthusiasm of high school teachers has become the urgent need of our country high schools in the reform of personnel system (WU, 2010). Only with scientific, impartial, strict inspection and objective and accurate evaluation of individuals at the same time add with the whole college teachers' ability and level, can we correctly guide university teachers' behavior, and help them to plan careers as well as to improve their working performance. Based on the analysis of teachers' work content, we design an evaluation index system in terms of teacher's teaching performance, scientific research and professional disciplines construction. We can use the principal component analysis to solve the multiple attribute evaluation. The evaluation result will be helpful to mobilize the enthusiasm of college teachers, improve the university's teaching research level. Besides, it opens up new prospects on college performance evaluation with strong practical significance.

1. PERFORMANCE EVALUATION INDEX SYSTEM
To design college teachers' performance evaluation index system, we set up a measure of value of college teachers, and then compare it with the behavior of college teachers and appraisal it, finally this paper draws the evaluation based on the value scale results. The assessment of college and university teachers should be evaluated from the following three aspects: teaching, providing students with a high level of education services; scientific research, making great efforts to improve the level of their scientific research; professional disciplines development, strengthening the role of them in the development of the discipline and school. Only these three dimensions co-front-runner, can we evaluate more objectively, thus the college teachers can develop better together with universities.

Based on the questionnaire and PCA analysis, we design the index system (MA & YANG, 2007) from teaching, scientific research and professional disciplines development that, see Table 1.

Table 1
College Teachers' Performance Evaluation System

Assessment objectives	Assessment dimensions	Evaluation index
College teachers' performance evaluation	Teaching	Teaching routine
		Students' evaluation
		Leadership comments
	Scientific research	Teacher proved
		Academic journals
		Research projects
		Academic conference
		Guide contest
		Study visiting
	Professional disciplines development	Course construction
		Discipline construction
		Professional construction

2. DATA DIMENSION REDUCTION AND COMPREHENSIVE EVALUATION BASED ON PCA

Principal Component Analysis, PCA, is a common multivariate statistical method (WANG & CHEN, 2006), and it is widely applied in the assessment of the related problems of sociology, economics and management, and is now becoming a practical value evaluation index technology (ZHANG, 2010). It is a study of how to through a handful of principal component (i.e. original variables linear combination) to explain multivariate variance-covariance structure. In particular, it is that a few main ingredients derived, let them as many of the original variables, and each other remain irrelevant. The main steps are:

- Samples data collection based on the selected index. The primitive matrix is constituted with *n* schemes and *p*index values:

$$X=\begin{pmatrix} x_{11} & x_{12} & \cdots & x_{1p} \\ x_{21} & x_{22} & \cdots & x_{2p} \\ \vdots & \vdots & \ddots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{np} \end{pmatrix}_{n\times p}$$

  Among them, x_{ij} is the j index value of i scheme

  $(i=1,2\cdots,n;j=1,2,\cdots,p)$

- Index data normalization to make dimension consistent. Standardization formula is stated as follows:

$$y_{ij}=\frac{x_{ij}-\overline{x}_j}{s_j}$$, Among them,

$$\overline{x}_j=\frac{1}{n}\sum_{i=1}^{n}x_{ij},\quad s_j=\sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_{ij}-\overline{x}_j)^2}$$

  (i = 1, 2$\cdots$, n; j =1, 2,$\cdots$, p). After transform the new material array, the sum of column of Y = (y_{ij}) is 0, the standard deviation is 1.

- Calculation the covariance matrix S of y.

$$s_{ij}=\frac{1}{n}\sum_{k=1}^{n}y_{ki}y_{kj}\quad(k=1,2\cdots,n)$$

- To solve characteristic root λ of matrix S and corresponding feature vector u.

  $\lambda_1\geq\lambda_2\geq\cdots\geq\lambda_p\geq 0$, so the i th main component is $z_i=u_i'X$

- To select the former m of principal components to structure the comprehensive evaluation function. We select principles for

$$\beta_m=\sum_{i=1}^{m}\lambda_i\Big/\sum_{i=1}^{p}\lambda_i\geq 85\%\,(1\leq m<p).$$

  So the former m of principal components z_1, z_2, ..., z_m, contains the 85% of original p indexes. Form one-way principal component decision matrix.

$$\hat{U}=\left[\hat{u}_{ij}\right]_{n\times m},\ \hat{u}_{ij}=u_{ij}-\min_i\{u_{ij}\}$$ And,

$$v^+=(v_1^+,\ldots,v_m^+),v_j^+=\max_i(v_{ij});v^-=(v_1^-,\ldots,v_m^-),v_j^-=0,$$

  So weighted principal component ideal point value function model is:

$$s_{7i}^+=\sqrt{\sum_{j=1}^{m}(v_{ij}-v_j^+)^2},s_{7i}^-=\sqrt{\sum_{j=1}^{m}(v_{ij}-v_j^-)^2},s_{7i}=\frac{s_{7i}^-}{s_{7i}^-+s_{7i}^+}$$

3. ILLUSTRATIVE EXAMPLE

In this section, an example about performance evaluation from 30 teachers, in a department of a university is used to illustrate the effectiveness of the proposed method, its normalization matrix see Table 2.

Using principal component analysis, we can get composition matrixes containing five principal component, see Table 3.

So, the normalized matrix can be transformed and it is shown in Table 4.

Table 2
Normalized Tables

	Index1	Index2	Index3	Index4	Index5	Index6	Index7	Index8	Index9	Index10	Index11	Index12
1	0.014	0.048	0.000	0.071	0.005	0.029	0.051	0.094	0.052	0.029	0.000	0.014
2	0.036	0.035	0.026	0.010	0.046	0.000	0.031	0.013	0.011	0.035	0.065	0.036
3	0.037	0.032	0.000	0.022	0.006	0.257	0.020	0.038	0.023	0.033	0.043	0.037
4	0.046	0.026	0.026	0.014	0.025	0.029	0.033	0.006	0.023	0.034	0.067	0.046
5	0.014	0.014	0.000	0.036	0.015	0.000	0.004	0.078	0.072	0.030	0.001	0.014
6	0.009	0.008	0.026	0.071	0.034	0.000	0.032	0.031	0.023	0.032	0.016	0.009
7	0.011	0.011	0.079	0.142	0.064	0.086	0.031	0.047	0.043	0.031	0.101	0.011
8	0.017	0.046	0.079	0.024	0.061	0.086	0.012	0.016	0.043	0.033	0.010	0.017
9	0.006	0.041	0.026	0.000	0.005	0.000	0.055	0.016	0.011	0.030	0.027	0.006
10	0.041	0.053	0.053	0.007	0.046	0.029	0.020	0.013	0.032	0.031	0.032	0.041
11	0.025	0.046	0.026	0.040	0.067	0.000	0.052	0.038	0.034	0.034	0.083	0.025
12	0.130	0.005	0.000	0.000	0.000	0.029	0.000	0.003	0.009	0.041	0.000	0.130
13	0.017	0.027	0.053	0.100	0.051	0.057	0.061	0.063	0.032	0.033	0.083	0.017
14	0.055	0.018	0.079	0.000	0.046	0.000	0.016	0.056	0.043	0.037	0.033	0.055
15	0.107	0.035	0.026	0.014	0.041	0.029	0.037	0.019	0.055	0.033	0.034	0.107
16	0.018	0.047	0.026	0.000	0.006	0.000	0.055	0.047	0.034	0.033	0.000	0.018
17	0.044	0.045	0.000	0.071	0.003	0.000	0.008	0.016	0.009	0.034	0.000	0.044
18	0.019	0.005	0.026	0.003	0.015	0.000	0.017	0.050	0.052	0.031	0.000	0.019
19	0.028	0.026	0.026	0.014	0.052	0.057	0.050	0.038	0.023	0.028	0.073	0.028
20	0.049	0.060	0.000	0.000	0.018	0.029	0.028	0.009	0.017	0.033	0.000	0.049
21	0.024	0.043	0.053	0.036	0.038	0.029	0.025	0.016	0.043	0.032	0.083	0.024
22	0.028	0.040	0.105	0.006	0.041	0.000	0.025	0.088	0.052	0.031	0.015	0.028
23	0.000	0.000	0.026	0.000	0.015	0.029	0.009	0.034	0.049	0.039	0.002	0.000
24	0.038	0.011	0.026	0.000	0.005	0.057	0.012	0.016	0.011	0.033	0.060	0.038
25	0.058	0.004	0.026	0.024	0.071	0.057	0.027	0.034	0.032	0.032	0.029	0.058
26	0.024	0.144	0.026	0.119	0.040	0.029	0.012	0.016	0.052	0.041	0.069	0.024
27	0.015	0.026	0.026	0.083	0.038	0.000	0.023	0.038	0.037	0.034	0.000	0.015
28	0.031	0.030	0.053	0.043	0.044	0.000	0.021	0.025	0.020	0.033	0.004	0.031
29	0.037	0.049	0.079	0.006	0.038	0.000	0.189	0.016	0.034	0.032	0.014	0.037
30	0.024	0.024	0.000	0.044	0.061	0.086	0.042	0.031	0.029	0.037	0.055	0.024

Table 3
Composition Matrix Table

	Composition				
	1	***2***	***3***	***4***	***5***
VAR00001	-.834	.181	.273	.284	.187
VAR00002	.116	.366	-.209	.183	-.701
VAR00003	.452	.296	.623	.156	.034
VAR00004	.495	.388	-.469	.206	-.056
VAR00005	.402	.666	.325	.152	.214
VAR00006	-.042	.273	-.424	-.266	.558
VAR00007	.234	.119	.553	-.407	-.328
VAR00008	.625	-.453	.002	.315	.309
VAR00009	.542	-.197	.075	.668	.092
VAR00010	-.484	.326	-.287	.434	-.242
VAR00011	.254	.776	-.106	-.184	.234
VAR00012	-.834	.181	.273	.284	.187

Table 4
Converting Form

	The data of prior to the conversion					One-way composition matrix				
1	0.1040	0.0906	-0.0294	-0.0099	-0.0053	0.3333	0.1602	0.1255	0.0268	0.1235
2	0.0003	0.0052	0.0133	0.0576	-0.0081	0.2295	0.0749	0.1683	0.0943	0.1207
3	-0.0186	0.0985	-0.1526	0.0706	-0.0344	0.2107	0.1681	0.0024	0.1073	0.0944
4	-0.0215	0.0066	-0.0161	0.0543	-0.0327	0.2078	0.0762	0.1389	0.0910	0.0961
5	0.0772	0.0312	-0.0040	-0.0348	-0.0079	0.3065	0.1008	0.1509	0.0019	0.1209
6	0.0748	0.0526	0.0155	0.0308	-0.0246	0.3041	0.1222	0.1705	0.0675	0.1043
7	0.1821	0.1198	0.0020	0.1248	-0.0607	0.4114	0.1894	0.1569	0.1615	0.0681
8	0.0685	0.0726	0.0219	0.0501	-0.0094	0.2978	0.1423	0.1768	0.0868	0.1195
9	0.0297	0.0317	0.0280	0.0377	0.0322	0.2590	0.1013	0.1829	0.0744	0.1610
10	0.0061	0.0235	0.0095	0.0372	-0.0193	0.2354	0.0932	0.1644	0.0739	0.1095
11	0.0812	0.0499	0.0442	0.0708	-0.0033	0.3105	0.1195	0.1992	0.1075	0.1255
12	-0.2293	-0.0697	-0.1549	-0.0367	-0.1288	0.0000	0.0000	0.0000	0.0000	0.0000
13	0.1429	0.1091	0.0003	0.0946	-0.0215	0.3722	0.1787	0.1552	0.1313	0.1073
14	0.0175	0.0104	-0.0015	0.0132	-0.0053	0.2468	0.0801	0.1534	0.0499	0.1235
15	-0.0966	-0.0010	-0.0626	-0.0049	-0.1021	0.1327	0.0687	0.0924	0.0318	0.0267
16	0.0346	0.0419	0.0133	-0.0011	0.0284	0.2639	0.1115	0.1683	0.0356	0.1572
17	-0.0305	0.0060	-0.0561	0.0051	-0.0731	0.1988	0.0757	0.0989	0.0418	0.0557
18	0.0369	0.0186	0.0082	-0.0191	0.0076	0.2662	0.0882	0.1632	0.0176	0.1364
19	0.0465	0.0561	0.0003	0.0677	0.0059	0.2758	0.1258	0.1553	0.1044	0.1347
20	-0.0627	0.0078	-0.0353	0.0019	-0.0309	0.1666	0.0774	0.1196	0.0386	0.0979
21	0.0657	0.0340	0.0268	0.0767	-0.0188	0.2949	0.1036	0.1817	0.1134	0.1100
22	0.1031	0.0540	0.0270	0.0093	0.0402	0.3324	0.1237	0.1820	0.0460	0.1690
23	0.0483	0.0236	0.0185	0.0017	0.0207	0.2776	0.0933	0.1734	0.0384	0.1495
24	-0.0324	-0.0024	-0.0498	0.0499	-0.0142	0.1969	0.0672	0.1051	0.0866	0.1146
25	-0.0092	0.0395	-0.0307	0.0236	-0.0481	0.2201	0.1091	0.1242	0.0603	0.0808
26	0.1020	0.0637	0.0150	0.0844	-0.0741	0.3313	0.1333	0.1699	0.1211	0.0548
27	0.0795	0.0572	0.0115	0.0143	-0.0405	0.3088	0.1269	0.1664	0.0510	0.0883
28	0.0316	0.0343	0.0092	0.0223	-0.0259	0.2609	0.1040	0.1641	0.0590	0.1029
29	0.0583	0.1331	0.0835	0.0501	0.0269	0.2876	0.2027	0.2385	0.0868	0.1557
30	0.0468	0.0713	-0.0147	0.0638	-0.0239	0.2761	0.1410	0.1403	0.1004	0.1049

Based on the method of ideal-point, in the following we can get:

Table 5

Serial number	Positive solutions	Negative solution	Similarity scale	Sort
1	0.04089	0.168486	0.804705	10
2	0.061201	0.110053	0.64263	21
3	0.105715	0.093096	0.468264	25
4	0.07765	0.085795	0.524917	24
5	0.05682	0.141511	0.713509	17
6	0.035636	0.151908	0.809986	9
7	0.017005	0.260485	0.938719	2
8	0.028397	0.161986	0.850843	6
9	0.04424	0.142266	0.762796	14
10	0.059667	0.108583	0.645367	20
11	0.023448	0.177676	0.883415	4
12	0.321846	0	0	30
13	0.013767	0.223307	0.94193	1
14	0.063886	0.108597	0.62961	22
15	0.154056	0.032581	0.174569	29
16	0.051	0.136375	0.727819	16
17	0.107968	0.059882	0.356759	27
18	0.061644	0.12418	0.668267	19
19	0.035668	0.145031	0.802611	11
20	0.109898	0.059138	0.349854	28
21	0.032408	0.155676	0.827694	8
22	0.029028	0.189565	0.867205	5
23	0.049652	0.139663	0.737728	15
24	0.090719	0.074975	0.452491	26
25	0.076425	0.085946	0.529319	23
26	0.030615	0.174051	0.850415	7
27	0.04019	0.14954	0.788173	12
28	0.052804	0.119889	0.694232	18
29	0.021091	0.212434	0.909684	3
30	0.039587	0.136887	0.775678	13

CONCLUSION

This paper presents a new method to solve the college teachers' performance evaluation problem. It designs a corresponding evaluation index system. The approach is based on the principal component analysis to form a one-way composition matrix. Meanwhile, it adopts weighted ideal point for comprehensive evaluation.

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