Academic Influence Evaluation Model for Research Institutes Based on Science Network Method: A Case Study

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Abstract—Academic influence evaluation is an important task in the research institution's evaluation, ranking and resources allocation. A science network method based academic influence evaluation model is proposed in this paper, which focus on building up a comprehensive model with consideration of the papers, projects, patents, academic services and other issues that may contributed to the influence. In order to verify the effectiveness of the model and the evaluation method, a four-collage case study is employed for demonstration. Numerical study shows that, the model and method proposed in this paper obtains quite similar result with the ranking of the colleges in their evaluation by the university, which helps to illustrate the effectiveness of the method. Based on the above calculation and research, this paper introduced three logical conclusions. School academic circles gradually expanded, each college academic influence has an increasing trend; Correlation coefficient between College of total influence and faculties published papers is maximum. Inter-faculty cooperation, the greater the influence of college.

Keywords- Science network model; academic influence；Evaluation Model ； university management; academic evaluation

I. INTRODUCTION

The global expansion of access to higher education has invoked the demand for academic quality evaluation and various university ranking in many countries all over the world. A recent UNESCO/CEPES conference on higher education indicators concluded that cross-national research on these ranking systems could make an important contribution to improve the international market of the higher education.

Some questions through a comparative analysis of university rankings in Australia, Canada, the UK, and the US is explored in paper [1]. So far, the academic study of ranking algorithm has already been taken into consideration in many countries. The task is usually formulated as a multiple attributes ranking problem, in which the goal is to produce a set of numerical scores, one for each attribute [2]. The ranking methods have been divided into six, somewhat overlapping, areas, etc [3]. In paper [4], it proposes a novel approach for designing and developing QoS ontology and its QoS-based ranking algorithm for evaluating Web services. Paper [5] proposes two ranking mechanisms for ranking product reviews: a consumer-oriented ranking mechanism ranks the reviews according to their expected helpfulness, and a manufacturer-oriented ranking mechanism ranks the reviews according to their expected effect on sales. An algorithm for ranking paths is reviewed being its complexity improved in terms of the required memory space. This improvement allows the ranking of really larger problems in reasonably small execution times, which is comprised by the presented computational experiments [6]. They present a formal model and a new search algorithm for folksonomies, called FolkRank, that exploits the structure of the folksonomy in paper [7]. In paper [8], they give a simple parallel algorithm for the list-ranking problem. The algorithm is a randomized $O(\log n)$ time, $n/\log n$ processor algorithm for an EREW PRAM. The algorithm is substantially simpler than other optimal algorithms for list-ranking. They propose a simple universal ranking algorithm for data lying in the Euclidean space, such as text or image data. The core idea of our method is to rank the data with respect to the intrinsic manifold structure collectively revealed by a great amount of data [9]. It indicates that the PageRank algorithm influences the ranking quality of websites by assigning the PageRank value on the average, and an improved algorithm based on hierarchic classification technology is proposed, and then the measure is carried out and the improved algorithm is tested [10]

II. MATHEMATICAL ACADEMIC INFLUENCE EVALUATION MODEL

A. Symbols and Variables Definition

Before we define the mathematical model of academic influence evaluation model, The symbols and variables definition is listed in table 1.

P	The total influence	x_{21}	The longitudinal project level
P_1	The paper influence	x_{22}	The rank of the longitudinal project
P_2	The longitudinal project influence	x_{23}	The Budget lines of longitudinal project
P_3	The patent influence	x_{31}	The patent type
P_4	The award influence	x_{32}	The patent rank
P_5	The academic part-time influence	x_{33}	The Adopted number of the patent
P_6	The transverse project influence	x_{41}	The award type
β_1	The paper influence weight coefficient	x_{42}	The award level
β_2	The longitudinal project influence weight coefficient	x_{43}	The award grade
β_3	The patent influence weight coefficient	x_{44}	The award rank
β_4	The award influence weight coefficient	x_{51}	The academic part-time level
β_5	The academic part-time influence weight coefficient	x_{52}	The academic part-time type
β_6	The transverse project influence weight coefficient	x_{53}	The academic part-time grade
x_{11}	The paper level	x_{61}	The transverse project
x_{12}	The rank of the author	x_{62}	The transverse project
x_{13}	The paper impact factor	x_{63}	Transverse project
x_{14}	The Adopted number of the paper	y_{ij}	The sum of x_{ij}

B. The Global Evaluation Model

The global evaluation model for an academic research institute's influence can be formulated as formula (1), where P is the global impact factor of the influence.

$$P=\sum_{i=1}^{n}\theta_i P_i \qquad (1)$$

Here θ_i is the weight ($i=1,2...n$); P_i is the influential factors. For the different academic research areas, the influential factors are different.

C. Weights Setting

In the comprehensive model, there are several weights that should be given to complete the calculation process. We proposed the weights setting scheme by superiority char, which is a method comparing indicators with each other: if the indicator i is more important than the indicator k, set indicator i as 1; if they are the same, then set both as 0.5; otherwise, score 0 for the inferior indicator. Thus we can calculate indicator i's weight with equation 2.

$$\lambda_i = \frac{\sum_{k=1}^{n}\alpha_{ik}}{n(n-1)/2+0.5n} \qquad (2)$$

In order to calculate the academic influence of a research institute, factors that may influence the final calculation can be sequenced with regarding to their importance in the literature. In this study, we argue the importance of the weights as: articles> academic part-time> longitudinal project> award influence> patents> transverse projects. Table 2 gives the description of the weights value setting in the study, which can also be illustrated with Figure 1.

TABLE II.   THE EXAMPLE OF THE WEIGHT CALCULATION

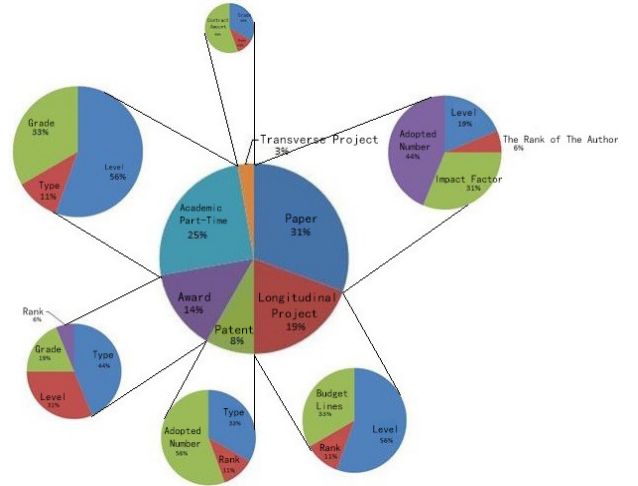| Academic research field	Paper	Longitu-dinal project	Patent	Award	Academic part-time	Transve-rse project	value
Paper	0.5	1	1	1	1	1	0.3056
Longitu-dinal project	0	0.5	1	1	0	1	0.1944
Patent	0	0	0.5	0	0	1	0.0833
Award	0	0	1	0.5	0	1	0.1389
Academic Part-time	0	1	1	1	1.5	1	0.2500
Transver-se project	0	0	0	0	0	0.5	0.0278

Figure 1.   Academic influence factors' weights setting for the comprehensive model

D. Academic Influence Classification Model

The comprehensive mathematical influence model can be described as formula (3).

$$P=\beta_1 P_1+\beta_2 P_2+\beta_3 P_3+\beta_4 P_4+\beta_5 P_5+\beta_6 P_6 \qquad (3)$$

Where, the paper influence sub-model is defined as formula (4).

$$P_1 = \alpha_{11} \frac{\ln(x_{11})}{\ln(y_{11})} + \alpha_{12} \frac{\ln(x_{12})}{\ln(y_{12})} + \alpha_{13} \frac{\ln(x_{13})}{\ln(y_{13})} + \alpha_{14} \frac{\ln(x_{14})}{\ln(y_{14})} \quad (4)$$

The longitudinal project influence sub-model is defined as formula (5).

$$P_2 = \alpha_{21} \frac{\ln(x_{21})}{\ln(y_{21})} + \alpha_{22} \frac{\ln(x_{22})}{\ln(y_{22})} + \alpha_{23} \frac{\ln(x_{23})}{\ln(y_{23})} \quad (5)$$

The patent influence sub-model is defined as formula (6).

$$P_3 = \alpha_{31} \frac{\ln(x_{31})}{\ln(y_{31})} + \alpha_{32} \frac{\ln(x_{32})}{\ln(y_{32})} + \alpha_{33} \frac{\ln(x_{33})}{\ln(y_{33})} \quad (6)$$

The award influence sub-model is defined as formula (7).

$$P_4 = \alpha_{41} \frac{\ln(x_{41})}{\ln(y_{41})} + \alpha_{42} \frac{\ln(x_{42})}{\ln(y_{42})} + \alpha_{43} \frac{\ln(x_{43})}{\ln(y_{43})} + \alpha_{44} \frac{\ln(x_{44})}{\ln(y_{44})} \quad (7)$$

The academic part-time service influence sub-model is defined as formula (8).

$$P_5 = \alpha_{51} \frac{\ln(x_{51})}{\ln(y_{51})} + \alpha_{52} \frac{\ln(x_{52})}{\ln(y_{52})} + \alpha_{53} \frac{\ln(x_{53})}{\ln(y_{53})} \quad (8)$$

The transverse project influence sub-model is defined as formula (9).

$$P_6 = \alpha_{61} \frac{\ln(x_{61})}{\ln(y_{61})} + \alpha_{62} \frac{\ln(x_{62})}{\ln(y_{62})} + \alpha_{63} \frac{\ln(x_{63})}{\ln(y_{63})} \quad (9)$$

III. CASE STUDY

A. *Problem Description*

In order to verify and validate the performance of our proposed evaluation model, we employ a four colleges academic research institute in a university of China as the case study, in which we explore the relationship between academic co-operations and influences.

B. *Academic Influence Development of the 4 Colleges in the University*

We firstly obtain the academic groups of the school/college between teachers who have been built into a partnership with another teacher of the university and been described as part of the partnership network diagram in the academic group. College, the center is surrounded by four colleges, each point representing college performance teachers in this year. As can be seen from the figure, the school's academic circle has expanded each year; the total impact of the college is also increased.
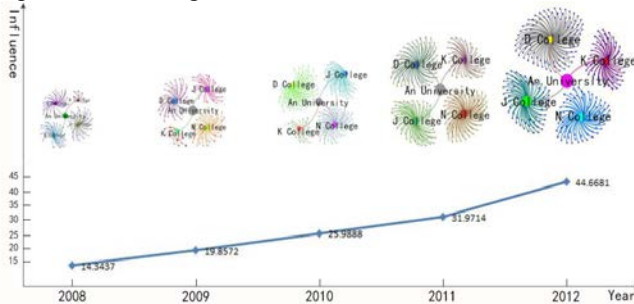

Figure 2.   The academic influence increasing trend of the university between 2008-2012.

C. *Academic Influence Development of College D*

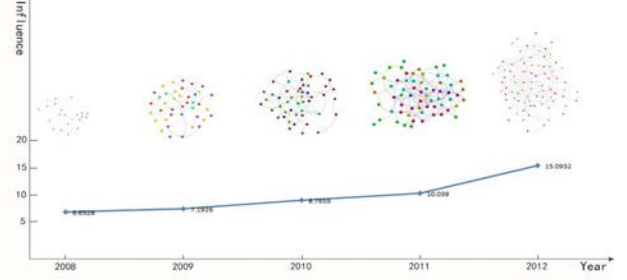The academic influence development of college D is shown as figure.3.

Figure 3.   College D's academic influence development during 2008-2012.

1) *Academic cooperation in collage D*

After the effective investigation, we obtain the academic cooperation between the teachers in College D during 2008-2012, as shown in Table 3.

TABLE III.   ACADEMIC COOPERATION IN COLLEGE D WITH ITS ACADEMIC INFLUENCE DEVELOPMENT (2008-2012)

	The number of the performance teachers	The maximum number of cooperation	College D academic influence
2008	30	2	6.6528
2009	45	3	7.1926
2010	50	4	8.7659
2011	65	5	10.039
2012	80	6	15.0932

According to the above data, College D academic scope during 2008-2012, academic cooperation between the performances of teachers and the development of influence, we found more cooperation, the greater the Academic influence

Among them, the College D in 2011, for example, the performance of teachers in academic circles there were 65 people, up to five times the average per capita cooperation, the annual college academic influence of 10.0390. As shown in Figure 4.
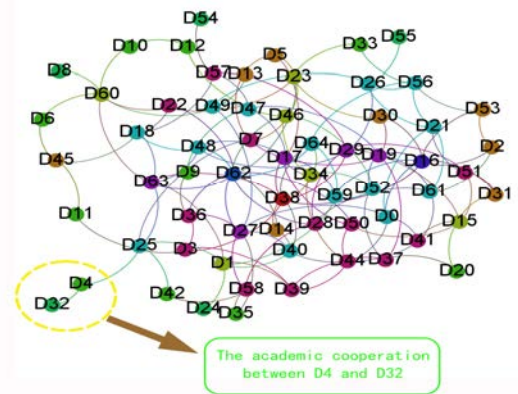

Figure 4.   The illustration of academic cooperation between teacher D4 and D32

2) Papers influence contribution

Apply formula (4) with the data of college D, we can obtain the papers influence contribution between 2008 to 2012, shown as Table 4.

TABLE IV.   PAPERS ACADEMIC INFLUENCE CONTRIBUTION IN COLLEGE D (2008-2012)

year	2008	2009	2010	2011	2012
paper	4.8902	2.985	6.5424	8.8871	13.961

3) Longitudinal projects influence calculation

Apply formula (5) with the data of college D, we can obtain the longitudinal projects influence contribution between 2008 to 2012, shown as Table 5.

TABLE V.   LONGITUDINAL PROJECTS ACADEMIC INFLUENCE CONTRIBUTION IN COLLEGE D (2008-2012)

year	2008	2009	2010	2011	2012
longitudinal project	13.2082	16.8851	19.0046	20.9164	34.2841

4) Calculation of the patents influence

Applying formula (6) with the data of college D, we can obtain the patents influence contribution between 2008 to 2012, shown as Table 6.

TABLE VI.   PATENTS ACADEMIC INFLUENCE CONTRIBUTION IN COLLEGE D (2008-2012)

year	2008	2009	2010	2011	2012
patent	0.396	2.4182	3.7366	7.2335	7.8862

5) Calculation of the awards influence

Apply formula (7) with the data of college D, we can obtain the awards influence contribution between 2008 to 2012, shown as Table 7.

TABLE VII.   AWARDS ACADEMIC INFLUENCE CONTRIBUTION IN COLLEGE D (2008-2012)

year	2008	2009	2010	2011	2012
award	8.2903	7.181	6.052	5.472	6.0616

6) Calculation of the academic part-time influence

Apply formula (8) with the data of college D, we can obtain the awards influence contribution between 2008 to 2012, shown as Table 8.

TABLE VIII.   ACADEMIC PART-TIME INFLUENCE CONTRIBUTION IN COLLEGE D (2008-2012)

Year	2008	2009	2010	2011	2012
academic part-time	0	0	0	0	0

7) Calculation of the transverse projects influence

Apply formula (9) with the data of college D, we can obtain the awards influence contribution between 2008 to 2012, shown as Table 9.

TABLE IX.   TRANSVERSE PROJECTS ACADEMIC INFLUENCE CONTRIBUTION IN COLLEGE D (2008-2012)

year	2008	2009	2010	2011	2012
transverse project	50.6137	64.7418	69.104	68.1699	95.8309

8) Calculation of the total influence

Apply formula (3) with the data of college D, we can obtain the total academic influence index between 2008 to 2012, shown as Table 10.

TABLE X.   THE TOTAL ACADEMIC INFLUENCE OF COLLEGE D DURING 2008-2012

year	2008	2009	2010	2011	2012
total influence	6.6528	7.1926	8.7659	10.039	15.0932

D. Academic influence and correlation analysis on college D

Application of formula (4)-(9), the above calculation for each year 2008-2012 influence various academic fields get collage D and the total influence, as shown in Table 11; through numerical correlation analysis to obtain the total influence and various factors, various factors correlation between indicators, as shown in Table 12.

TABLE XI.   ACADEMIC INFLUENCE DEVELOPMENT OF COLLAGE D DURING 2008—2012

	Paper	Longitudinal Project	Patent	Award	Academic part-time	Transverse project	Total influence
2008	4.8902	13.2082	0.3960	8.2903	0	50.6137	6.6528
2009	2.9850	16.8851	2.4182	7.1810	0	64.7418	7.1926
2010	6.5424	19.0046	3.7366	6.0520	0	69.1040	8.7659
2011	8.8871	20.9164	7.2335	5.4720	0	68.1699	10.0390
2012	13.9610	34.2841	7.8862	6.0616	0	95.8309	15.0932

TABLE XII.   THE CORRELATION ANALYSIS BETWEEN DIFFERENT SUB-INFLUENCE COMPONENTS WITHIN COLLEGE D

	Paper	Longitudinal project	Patent	Award	Transverse project	Total influence
Paper	1.0000					
Longitudinal project	0.9297	1.0000				
Patent	0.8613	0.8476	1.0000			
Award	-0.6063	-0.5957	-0.8816	1.0000		
Transverse project	0.8624	0.9830	0.8307	-0.6398	1.0000	
Total influence	0.9700	0.9912	0.8727	-0.6177	0.9565	1.0000

IV. CONCLUSION

This paper established a mathematical model of academic influence, and depending on the influence of academic areas populated model calculations. Academic circles over the years, and given the influence of changes in the development of a school, and take the collage D for

example, demonstrate academic cooperation between the Institute of Internal Performance teacher relationships with the college academic influence.

Based on the above calculation and research, this paper introduced three logical conclusions:

- school academic circles gradually expanded, each college academic influence has an increasing trend;
- Correlation coefficient between College of total influence and faculties published papers is maximum.
- Inter-faculty cooperation, the greater the influence of college.

Accordingly, we propose the following recommendations for academic and research institutions to improve the academic influence:

- Academic and research institutions can formulate relevant policies to encourage college papers published papers in order to enhance the school influence.
- Academic research institutions can encourage cooperation among teachers, improve academic achievement, in order to enhance the influence of the school.

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