An Evaluation Model of Academic Record of Electronic and Information Engineering Base on Complex Network Theory

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Abstract. Student test results are important basis to measure study situation. It is an important method to evaluate the quality of professional personnel training by using students' test scores. This paper construct a curriculum influence value network using the interaction relationship between the courses of electronic information engineering based on complex network theory. Then, the test scores of each subject have been entered into the curriculum influence value network to get the grade evaluation network model of students. Finally, evaluate the quality of professional personnel training of students according to the structural characteristics of the grade evaluation network model. In this paper, we use this model to evaluate the personnel training quality of 10 graduates of electronic information engineering. The results show that the grade evaluation network model can accurately measure the quality of professional personnel training of electronic information engineering students.

Introduction

It is an important content of the university personnel training evaluation system to base on the evaluation of student achievement. A good performance evaluation system can accurately reflect the quality of professional personnel training. The electronic information engineering of colleges has trained a large number of professionals in the field of information industry, which have the basic knowledge of electronic technology, information systems and information characteristics, etc., and can be engaged in various types of electronic equipment and information systems research, design, application and development, etc. At present, the research on the evaluation theory of College Students' examination and evaluation is focused on the quality evaluation of electronic information. The evaluation methods are diversified, the content of evaluation is flexible, and the evaluation standard is not unified. The vast majority of evaluation methods attach great importance to the process of evaluation and the development of the scale. But the key project score of the treatment and evaluation is still very rough. More methods are still in place to the static test ranking, mean, standard deviation, and some even avoid grade evaluation [1-7]. In this paper, we use the influence relationship between each course and the results of each course to establish the network model of student achievement evaluation, according to the structure of the network model to measure the quality of professional personnel training.

Construction of the Complex Network Model of Grade Evaluation of Electronic Information Engineering Students

Courses of Electronic Information Engineering. Electronic information engineering is a subject used in modern technology such as computer and electronic information control and information processing. The main research are information acquisition and processing, electronic equipment and information systems design, development, application and integration. It set up a total of 70 multi course include the circuit theory, information theory and coding, signal and system, digital signal processing, electromagnetic theory, automatic control principle, etc. We have selected 66 important

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courses which affect the relationship between the students and the students, specific courses as shown in Table 1.

Table 1 Courses of electronic information engineering

No.	Course name	No.	Course name	No.	Course name
1	Basic manufacturing technology practice	23	Linear Algebra	45	Industrial field bus control technology
2	VC++ practice	24	Probability and Statistics	46	Knowledge extension of signal and system theory
3	Electronic technology practice	25	Complex Analysis and Integral Transformation	47	Electronic System Design
4	EDA practice	26	Physics of college	48	DSP Technology and Application
5	Production practice	27	Physics of college experiment	49	Image Processing Technique
6	MCU interface practice	28	Analog Electronic Technique	50	Electromagnetic Field Theory
7	ARM information system practice	29	Circuit Theory	51	Electronic Measurement
8	DSP practice	30	Digital Electronic Technique	52	Television technique
9	Image processing practice	31	Analog Electronic Technique experiment	53	DSP Engineering Case Analysis
10	Electronic system engineering practice	32	Digital Electronic Technique experiment	54	Technology of Information and Coding
11	Graduation practice	33	The Professional Introduction	55	Digital Speech Processing Technique
12	Graduation design	34	Micro-Computer Principle And Application	56	Pattern Identificatio nand Application
13	Circuit CAD practice	35	The Special English	57	Multimedia technique
14	Electronic circuit practice	36	Sensors Technology	58	Digital communication system
15	Digital electronic practice	37	JaveProgram Designing	59	Optical Fiber Communication Techniques
16	Electronic CAD practice	38	VC++ Programing	60	The New technology of electronic information
17	DSP Comprehensive Practice	39	Single-chip Micro-computer And Interface Technology	61	Application Technology of Database
18	College Chinese	40	Mechanical Drawing and CAD	62	Microwave Technique
19	College Foreign Language	41	Signal and System	63	Computer Networks
20	University Computer Foundation	42	The Principle of Communication	64	Embedded Systems and Application
21	Computer programming (C language)	43	High frequency electronics Technology	65	EDA Technology and Application
22	Advanced Mathematics	44	Digital Signal Processing	66	Automatic Control Theory

Construction of Curriculum Influence Value Network Model. We construct curriculum impact weight network according to the mutual influence relationship of course. The network is a directed weight network. Node in the network is a course in Table 3. The edge of the network is influenced by the relationship, which from the first courses to the application course. The value of edges are the proportion of the knowledge of first course in application course. For example, higher mathematics course is the first course of signal and system course. More than 50% knowledge of signal and system course are related to the knowledge of higher mathematics. Therefore, there is a point between the two

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nodes of higher mathematics and signal and system, and the weight of edge is 0.5. The curriculum affecting value network model of electronic information engineering as shown in Fig. 1.

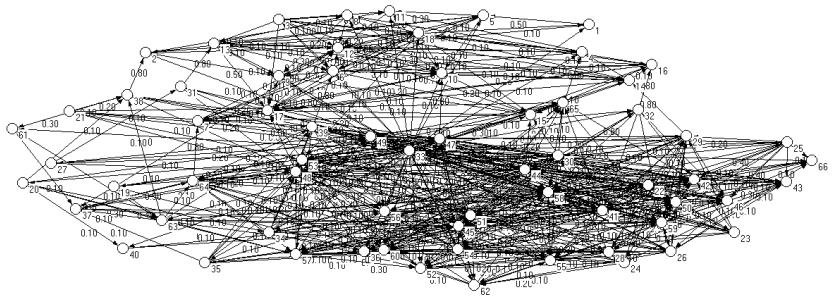

Figure 1. Curriculum influence value network model

Construction of Grade Evaluation Network Model. The curriculum influence value network reflects the influence degree of each course of electronic information engineering. Due to the different grades of different students, we combine the achievement of students and the value network to build the grade evaluation network. The grade evaluation network is divided into two kinds of positive network and reverse network. The weight of the edge of the forward network is equal to the result of the first course and the product of the weight of the edge of the network and the reverse network is equal to 1 minus the weight of the positive network. For example, the grades of all subjects of an electronic information engineering student are shown in Table 2, and then the grade evaluation networks are shown in Fig. 2.

Table 2 High and low settings of predictor variables

Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Grades	70	80	80	70	80	60	72	70	80	80	80	80	80	80	80	70	80
Number	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Grades	90	74	77	83	95	77	72	84	85	90	91	80	74	80	80	70	73
Number	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
Grades	80	70	80	70	80	80	60	80	62	87	80	80	60	63	80	70	68
Number	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66		
Grades	80	63	62	80	80	80	80	80	80	80	80	92	80	74	80		

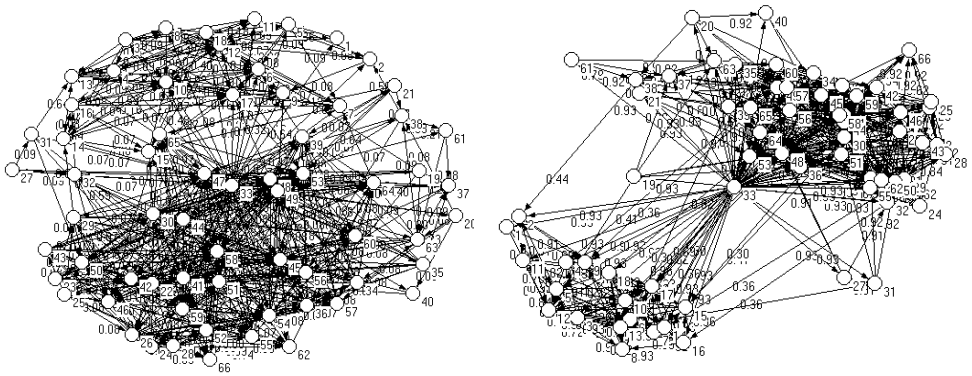

Figure 2. The forward and reverse grade evaluation networks

Degree Centrality. The degree of a vertex in a network is the sum of weight of all the links connected to it [8]. For grade evaluation network, there are an out-degree k_{out} and an in-degree k_{in} which are, respectively, the sum of regulating and regulated relations at the node, as shown in Eq. 1.

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$$k_i^{out} = \sum_{j=1}^{n} A_{ij}, \quad k_j^{in} = \sum_{i=1}^{n} A_{ij} \tag{1}$$

Where A is the adjacency matrix of network, A_{ij} is an element of matrix A, $A_{ij}\neq 0$ if there is a link from node i to node j, the value of A_{ij} is the weight of edge.The total degree k_i of a node n_i can be computed by the sum of them, i.e., $k_i = k_i^{in} + k_i^{out}$.

Closeness Centrality. Closeness centrality measures the mean distance from a vertex to other vertices. A path in a graph is a sequence of nodes and edges, such that a node belongs only to the edges before and after it, and no nodes are repeated [9]. A path length is the sum of edges weight in the path. The smallest sum of edges weight that have to be traversed in a network to get from one node to another is called the distance between the two nodes and a path through the network that achieves that distance is called the shortest path between the nodes. In a teaching evaluation network, there are in-closeness and out-closeness which are, respectively, measures the distance with regulating and regulated nodes. We define d_{ij} is the shortest path length from i to j. Then the closeness centrality of node i is the average of the inverse distances, as shown in Eq. 2.

$$C_i^{in} = \frac{1}{n-1} \sum_{j(\neq i)} \frac{1}{d_{ji}} \tag{2}$$

Where C_i^{in} is the in-closeness of node i.

Result of Application

We constructed 10 network model of electronic information engineering students using the above method and then calculated average of in-degree, in-closeness and graduation design in-closeness of them [10]. These characteristics of network structure can measure the quality of students training from different angles. The in-degree, in-closeness, graduation design in-closeness, grade point average and learning evaluation value of 10 electronic information engineering students as shown in Table 3, and the normalized results are shown in Fig. 3.

Table 3 High and low settings of predictor variables

Student number	In-degree	In-closeness	Graduation In-closeness	Average	Evaluation value
1	0.876787879	0.780832686	0.730840119	67.24242424	9.343
2	0.875742424	0.780273195	0.738822374	67.90909091	9.326
3	0.900939394	0.78315689	0.739940425	69.04545455	9.277
4	0.89469697	0.783253308	0.739217757	68.98484848	9.391
5	0.899727273	0.781688579	0.74377202	70.25757576	9.431
6	0.907348485	0.783159632	0.739861417	70.04545455	9.41
7	0.934848485	0.789257507	0.751921833	72.68181818	9.385
8	1.017924242	0.805080969	0.7705511	77.09090909	9.711
9	1.000712121	0.798904592	0.773998251	76.68181818	9.664
10	1.122469697	0.822506542	0.806489599	83.59090909	9.986

As shown in Fig. 3, the distribution characteristics of in-degree averages are similar to the grade point averages. The distribution characteristics of in-closeness averages, graduation design in-closeness averages are similar to the learning evaluation values. This illustrates using the structural characteristics of the network are more fully and accurately evaluate the quality of electronic information professional students training than the simple average value of the course grades.

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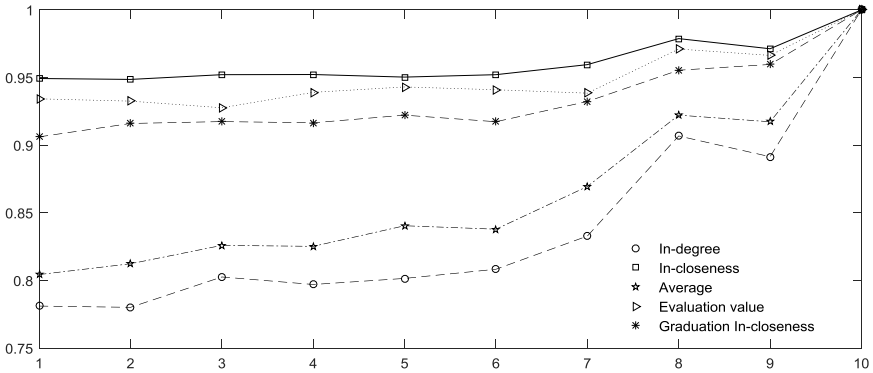

Figure 3. Finite element calculation model of arch dam and bedrock

Conclusion

The grade evaluation network will be useful to evaluate the quality of electronic information professional students training. Building a grade evaluation network model is a guarantee to promote the students training quality management in higher vocational colleges. Establishing a high quality of students training evaluation network model is directly related to the healthy development of the vocational education. It is the inevitable developing trend of scientific management in the 21st century education and is inevitable requirement of education facing the modernization, the world and the future.

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