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On the Correlation between Centrality Measures and Peer Review: Case of Abrar University

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Abstract: One of the most important problems that developing countries are involving is education development. Learning management as one problem in education development has some familiar problems such as one of the problems in finding best location for educational sites or tuning the relationship between teachers and students. One of the most important problems in this area is student evaluation in schools and universities. There are two well-known strategies in the world, the first one is named as Teacher based and the second one is named as Student based (peer evaluation). This paper is dealing with this issue that whether the students based strategy is fair or not. To do this, this paper is trying to analyze the students' centralities and obtained grades based on two above mentioned strategies. Our findings supported that obtained grades through peer evaluation strategy was significantly positively correlated with the some centrality measures. All of data have been gathered in some courses in Abrar University in 2013-2014 academic year.

Keywords: Social network analysis; student evaluation; centrality measures; grading, case study

1 INTRODUCTION

Social Networks Analysis (SNA) started to develop in the early 1920s and focuses on relationships among social entities, as communication between members of a group, trades among nations, or economic transactions between corporations [1]. In recent decades, SNA has increasingly attracted researchers' attention from different disciplines such as mathematics, physics, computer science, biology and social sciences.

The main focus of the network approach, which has formed SNA, is on the concept of relationships patterns between system components. In other words,

SNA aims to model and analysis the relationships between actors. Graph theory provides proper materials and tools for this purpose. Such modeling approach and tools have been used in labor market analysis [2], studying the friendship and personal relationships [3, 4], analyzing the political relationship between countries [5], analyzing the organizations' connectedness [6], supply chain management [7] and some other applications [8, 9].

In addition, many important problems were grown in this area, for instance; how events and attributes are diffused and distributed among human beings? Why gossip spreads faster than realities? How traffic

congestion occurs and can be eased? Is there any correlation between topological feature of nodes and their performance in real world? Can we define the importance of nodes based on their position in network?

One of the main issues in complex network is evaluation of nodes based on their power. The concept of “centrality” is introduced for modeling the nodes’ power. The basic theories tell that the more connected to other nodes, the more important node. But there exist many approach for modelling the node’s power or importance in the literature.

Freeman [10] suggests three criteria for centrality of the node after studying all existing centrality measures: (1) “Degree” which can be actually used as a measure for assessment of active relations in a network; (2) “Betweenness” which is based on the number of times a node is located as a middle node in the shortest path between the other nodes and is used as a measure for controlling the relations potentially; (3) “Closeness” which is based on how close a node is to all the other nodes of the network and it is used to display independency and/or efficiency of the relations. It is evident that these three measures investigate the power of nodes from three different points of view. Other studies have developed a wide range of centralities as some measures of importance such as [8]. From an application point of view, some studies have been performed about existence of relation between nodes’ centrality and their real world performance in different situation. For example, Orr *et al.* show that the person’s shyness is significantly negatively correlated with the number of friends they have (their degree centrality). So, in this paper we are dealing with to one of the most important problem in learning management that is named as “peer evaluation” using SNA tools and methods. On the other words, we want to know whether it is fairly to grade students by other students or not. In order to do this research we consider two strategies for grading students; grading by teacher and grading by other students in the class. In the first method, the teacher gives a grade to each of students which is the final grade for them. In second one, each student gives grade to other students and the final grade for each one is the average of obtained grades by her classmates. To do this, we construct the students’ friendship networks and analyze the correlation between students’ obtained grades in peer evaluation with their different centralities in related network.

The reminder of present paper consists of 4 sections. In section 0, a review of the works those are dealt with to similar problems, has been performed. Next, we define our problem completely in section 3 and a

definition of dataset that has been used in this paper is mentioned in section. Section 1, dealing with computational results, conclusion and future research suggestions.

2 PRIOR STUDY

Some of the researches in SNA area have been focused on the comparison one of the nodes’ features in network with one of their issues in real worlds. For example, Zargari Asl *et al.* [11] considered a group of female students at a university. They compared educational performance students with four centrality measures in their mobile networks in order to evaluate how their educational performance is related to their centralities. E.S. Orr *et al.* [12] investigated the relation between shyness of Facebook users with the number of contacts added to her profile. They showed that shyness was positively correlated with the time spent on Facebook and having favorable attitudes toward the social network site, and shyness was negatively correlated with the number of Face book friends. Y. Imamverdiyev *et al.* [13] considered six different social network centralities of 48 undergraduate students in three disciplines (Power engineering, Electronics engineering and Sociology) and investigated the existence relation between these centralities with their emotional intelligence. They constructed a social network based on their mobile phone logs 37 days. EI scores were also obtained from a standard IQ questionnaires. R. Alguliyev *et al.* [14] traced the number of subscribers of an individual mobile center in a month to retrieve the social behavior in a province. They showed the relation between population behavior and mobile subscribers’ activity. They have focused on a province’s mobile station information in official working days, weekends and holidays. Banerjee *et al.* [8] examined how participation in a microfinance program diffuses through social networks in some villages in south of India. They found that the diffusion of microfinance is influenced by the first contact person and show that diffusion is positively correlated with first contact’s centralities. W. Farmer *et al.* [15] analyzed relations between social network centralities and behavioral characteristics. Elementary school students nominated classmates for aggressively, disruptiveness, popularity, studiousness, leadership, cooperativeness, athleticism, and shyness. Students had 1 of 4 levels of network centrality (i.e., nuclear, secondary, peripheral, isolated) and were in 1 of 4 educational classifications (i.e., academically gifted, emotionally and behaviorally disordered, general education, learning disabled). A summary of such works is shown in Table 1.

According to above mentioned works, we are dealing with a problem in learning management that is

named as peer evaluation. This paper is trying to compare two strategies of grading; Student based (peer evaluation) and Teacher based. So, this paper

is analyzing the correlation between students' centrality and their obtained grades in two above-mentioned strategies.

Table 1. A summary of the literature

Row	Year	Author	Centrality measures	Real property	Ref.
1	2013	A.Banerjee <i>et al.</i>	Eigenvector	Diffusion of Microfinance	(8)
			Degree		
			Closeness		
2	2009	E. S. Orr <i>et al.</i>	Betweenness	Shyness	(12)
			Degree		
			Degree		
3	2011	H. Z. Asl, <i>et al.</i>	Betweenness	Educational performance	(11)
			Degree		
4	2011	Y. Imamverdyev, <i>et al.</i>	Eigenvector	Emotional Intelligence	(13)
			Bonacich		
			Betweenness		
5	1996	T.W.Farmer, <i>et al.</i>	Non familiar measures	Educational classifications	(15)

3 PROBLEM DEFINITION

This paper considers some courses in Abrar University as a sample. Abrar is a single-sex university in Tehran that has more than 800 students in 3 disciplines. We interviewed more than 150 students and after data cleaning we work on information of 90 students. These students were registered in 4 courses. In each course, students were divided in some groups with two partner. Each group proposed a project in course and other students and teacher give grades to them.

This dataset is used in other researches such as [1, 2],

1- Kermani, M. A. M. A., Badiee, A., Aliahmadi, A., Ghazanfari, M., & Kalantari, H. (2016). Introducing a procedure for developing a novel centrality measure (Sociability Centrality) for social networks using TOPSIS method and genetic algorithm. *Computers in Human Behavior*, 56, 295-305.

2- Agha Mohammad Ali Kermani, M., Aliahmadi, A., & Hanneman, R. (2015). Optimizing the choice of influential nodes for diffusion on a social network. *International Journal of Communication Systems*.

So, each group obtained two grades; the first one is the grade given by teacher (teacher based

evaluation) and the other one is the average of the grades given by other students (peer evaluation).

In order to perform the research, we construct a separated network in each course. For constructing the related networks, we consider each student's relationships with other students. In these networks, students are the nodes and links can be formed in several ways. It means that in each course we construct several networks based on different link formation strategies. The link formation and their relate weights in this paper is summarized in Table 2.

Based on link description and related weights, we constructed 10 different networks in each course. As, there are some works in the literature that construct a final network based on some existing network (e.g. (8)), we should aggregate 10 existing networks. The aggregation strategy is as follow:

- **Link presence:** There is an undirected link between nodes i and j , if there is at least one link between i and j in one of the existing networks.
- **Link weight:** A link's weight between i and j in aggregated network is equal to sum

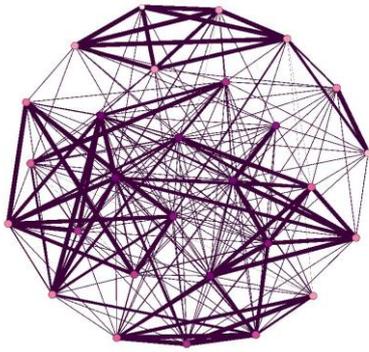


Fig. 1. Aggregated network in transportation course

of link's weights between i and j in all of the existing networks.

The aggregated network in one course (Transportation Course) has been depicted in Fig. 1.

Now we calculate some of the nodes' centrality measures in aggregated networks such as Degree, Betweenness, PageRank and Eigenvector. A comprehensive introduction to the above mentioned centralities is expressed in [16].

Table 1. Link formation in network

Link Formation Strategy	Explanation	Weighted	Weighted			Weights Explanation
			Weak	Medium	Strong	
Based on project cooperation	If a node cooperate on a projects with another nodes in past courses	Yes (number of projects is defined as the link's weight)	0	1	2	It means that if they worked on a mutual project in past, the connecting link's weight set one and if there were more than one, link's weight should be set two
Based on social activity in university	If a node is taking part in a social activity at university with another node	Yes (amount of time spent with another nodes at university.)	0	1	2	It means that if they take part in a mutual social activity in university one time per week, the connecting link's weight set one and if they take part more than one, link's weight should be set two
Based on social activity out of University	If a node has spent time out of university with another nodes.	Yes (amount of time spent with another nodes out of university.)	0	1	2	It means that if they take part in a mutual social activity out of university one time per week, the connecting link's weight set one and if they take part more than one, link's weight should be set two
Based on the time in path from home to university	If a node has gone to university with another nodes.	Yes (amount of time spent with another nodes during path to university.)	0	1	2	It means that if they spend less than one hour in path to university, the connecting link's weight set one and if it is more than one hour, link's weight should be set two
Based on mobile phone number	If a node has the others Mobile phone number in her contact list	No	--	--	--	---
Based on home phone number	If a node has the other node's home number	No	--	--	--	---

4 COMPUTATIONAL RESULTS

This paper is dealing with this issue that whether the peer evaluation in universities is fair or not. So, in this section, it has been shown that the students' grades based on peer evaluation have a significant positive correlation with their centrality measures (see Table 3).

So, it can be concluded in evaluation of students, peer evaluation is not a fair strategy and the obtained grades have a very good correlation with some of centrality measure such as Eigenvector.

It means that the nodes with higher eigenvector have grade based on her situation in aggregated network. As it is mentioned in above sections, students work on their project in pairs. So, the other hypothesis is, that there is more correlation between the maximum centrality in each group with the obtained grade by group. This fact is shown in Table 4. It means that if there is a person in a group who has a strong relationship with other classmates, the group will obtain a high grade. Totally, Table 3 and Table 4 show that obtained grades based on Student Based Strategy is biased.

Table 3. Correlation between students' grade in group and centrality measures

Centrality Measure	Degree	Betweenness	PageRank	Eigenvector
Correlation	0.561	0.424	0.551	0.589

Table 4. Correlation between students' grade in group and maximum centrality measures of in group person

Centrality Measure	Degree	Betweenness	PageRank	Eigenvector
Correlation	0.742	0.644	0.742	0.734

Table 5. Correlation between centrality measures and the students' grades given by teacher

Centrality Measure	Degree	Betweenness	PageRank	Eigenvector
Correlation	0.1	-0.005	-0.092	-0.123

In addition, correlation between students' obtained grades through teacher based strategy with students' centrality measure and maximum centrality measures in group is shown in Table 5 and Table 6.

Table 6. Correlation between maximum of the group's grade and the maximum of person's indexes in group

Centrality Measure	Degree	Betweenness	PageRank	Eigenvector
Correlation	-0.065	0.165	-0.044	-0.137

It has been proven that the grades which given by teacher are not correlate with centrality measures of students and there is not any relation between these data.

Totally, it could be concluded that the peer evaluation in universities and schools is not a fair and utilizing the teacher based evaluation for evaluating the students is a more accurate strategy.

5 CONCLUSION

This paper is trying to cope one of the important problem in learning management, named as student evaluation. We were trying to compare two of well-known strategies in student evaluation, i.e., *Student Based Strategy* and *Teacher Based Strategy*. Since, it has been proved that there is high correlation between the grades given in *Student Based Strategy* with network centrality measures, so it can be conclude that this strategy is not fair and students do this based on their friendliness. All in all, it is not a good suggestion for schools and universities' teacher to evaluate their student based on this strategy.

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