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PERSONAL SHARING IN SOCIAL NETWORK ANALYSIS – A CASE STUDY IN UNIVERSITI MALAYSIA TERENGGANU

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ABSTRACT

In this paper, we discuss a case-study of personal sharing of information among students of two undergraduate programme, i.e., Computational Mathematics and Software Engineering (in short, CM and SE respectively) at Universiti Malaysia Terengganu, Malaysia. The data collected is represented as a directed graph with edges between vertices representing information sharing between the focused-group of students. An analysis is carried out to identify reciprocity, influential individuals and community formation to understand the dynamics of these two groups. Even though the density of CM and SE students' network are somewhat similar, but higher number of reciprocities and communities exists in CM network which indicates resource sharing can be limited in a particular network. However, two isolated vertices also exist for CM which indicates these students prefer to work alone thus in need of extra attention. It is expected that with the community information derived, we can use it to sustain the dynamics of the network and further boost teaching and learning using various divide-and-conquer strategies.

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INTRODUCTION

Electronic devices like computers, mobiles or other data-processing devices are assumed as vertices (shortly, V) while the relationships between them can be represented as edges (shortly, E). The collection of vertices and edges can be represented in the form of a network or known as a graph G denoted by $G(V,E)$. Network analysis (NA) measures the dynamics of behavior and interaction among these nodes and how they are connected at three scales; individuals, groups and organizations. NA is a well-known process of quantifying the network traffic to provide better Quality of Services (QoS). Modern commercial networks demand highly scalable and reliable service through integrated techniques among the network nodes.

In the last decade, sociologists and mathematicians have investigated social networks where the vertices represent individuals, organizations, countries etc., denoted as actors. The investigation of social network gave birth to a new field of study called Social Network Analysis (SNA) [1, 2]. SNA deals with the analysis of connectivity among actors and the process of elucidating intrinsic information in a social circle. The basic assumption is that better explanations of social phenomena can be depicted by tracking various types of relations among the entities.

Friendship is a fundamental characteristic of human relationships in which two parties share common understanding, emotional support and capital resources [3]. However,

friendship between two individuals is not an equal phenomenon, in which we can divide it into two categories; reciprocated and unreciprocated relationship [4]. Reciprocity refers to the presence of the arc (i,j) when (j,i) is an arc. If (i,j) is an arc and (j,i) is not, we may call (i,j) a one way or unreciprocated arc and such arcs usually represent hierarchical or patron-client relationship, whereas reciprocated arcs indicate some sort of balance. For example, Ali may think Aminah is his friend, however, if Aminah does not consider Ali as a friend, then it is an unreciprocated friendship.

Reciprocity is defined as the act of responding positively to a positive action with a positive action of one's own, and it is used to form, maintain, and enhance various social ties. It is the foundation of social order and is a major key to success. This applies not only in social networking but also in human activities. The potential for reciprocity actions by players increase the rate of contribution to the public good and reciprocity is a form of social obligation and it is a motivation for returning favors from others. Reciprocity was studied and evaluated from the beginning of SNA in the 1930's. A measure of reciprocity is a number which gives the extent to which support is both given and received in a relationship. In the context of a friendship network, which has reciprocal ties, the balance of understanding, power, resources and pysho-social support can been seen [4].

The concept of reciprocity in various social and marital networks has been studied as well. For example, the network of a village in West Bengal, India was investigated in several papers [5, 6, 7]. Vasanthi *et al*. [8] considered the concept of reciprocity in the study of personal sharing among students of postgraduate programmes at two different universities in India. Similarly, Vaquera and Kao [4] studied friendship and reciprocity among adolescents using National Longitudinal Study of Adolescent dataset.

Moody [3] stated that the friendship choices between schoolmates capture much of their social universe. However, the friendships that occur at the latter part of life are said to be complex in nature due to its diversity, thus defeating a single setting for a detailed analysis. In line with this fact, we analyse the concept of reciprocity by constructing directed graphs using two set of data collected from 20 respondents of third,year undergraduate students from Computational Mathematics (CM) and Software Engineering (SE) programme at Universiti Malaysia Terengganu, where the data were collected from the students y who had spent three years together and hence all of them knew each other well. Each student was asked to provide a list of students in the class who he or she shared his or her personal problems and the same students were crosschecked with same data for validation. Since the friendship network is asymmetric in relation, the collected data give a directed graph $D = (V, A)$ where the vertex V is the set of 20 students and (u, v) is an arc in A if u shares his or her personal problem with v. For convenience, the students are labelled with the numbers 1 to 20.

In this research, we consider two measures namely individual and community where the former is based on *in-degree* and *out-degree* measures. In-degree means the number of edges directed towards an individual that is the number of interactions he or she receives. Out-degree is the number of edges originating from the individual that is the number of interactions he or she initiates. For community detection, we used modularity clustering method, which was first proposed by Newman and Girvan [9] and is available in various SNA software. This measure has been used widely in various fields, e.g., Gobithaasan *et al.* [10] showed that an instructor can use Neuman and Girvan measure to create assignment groups among students and developed well-balanced groups to indirectly boost the performance of students.

MAIN RESULTS

Computational Mathematics (CM) of Friendship Network

Among the 20 vertices in the directed graph generated for CM students, nine vertices represent male students and 11 vertices represent female students. The set of male students and the set of female students are $M = \{1,6,7,8,9,10,11,12,20\}$ and $F = V - M = \{2,3,4,5,13,14,15,16,17,18,19\}$, respectively. The resulted directed graph is given in Figure 1.

There are seven reciprocal pairs of arcs. From the seven of reciprocal pairs of arcs, there are five female and female pairs and two male and female pairs. Hence, this network has graph reciprocity measure 14/29 = 0.482759. Out of the total number of 29 arcs, personal sharing between male students is quite rare. Taking into the account the surrounding of CM students, it can be understood that male students mostly like to share their problems with female companions and prefer to be a listener of their friend's problems.

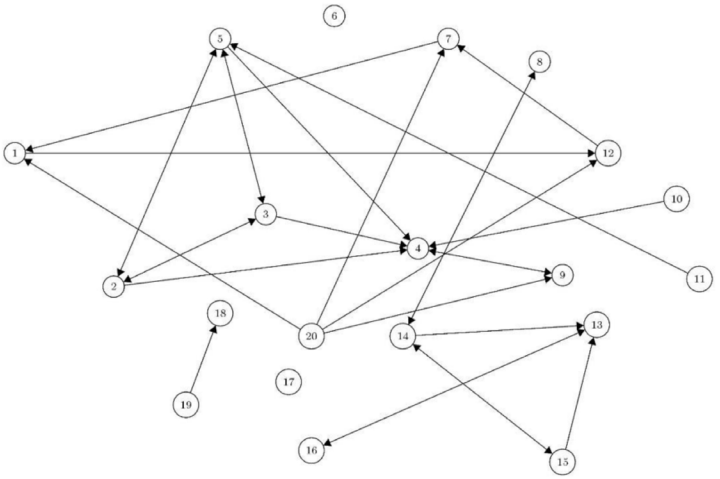

Figure 1: Directed graph based on in-degree and out-degree for CM students

The higher number of reciprocal pairs of the female students shows that personal sharing is more frequent among female students. This is perhaps because of female students being more comfortable to share their problems with their friends compared to male students. The vertex 4 has in-degree 5, indicating that more students like to approach her for personal sharing and the most popular within the group. There are six vertices have in-degree 0, which are 6,10,11,17,19 and 20. Vertex 20 has the highest out-degree, showing that this person shares problems to others but nobody comes to him. The vertices 6 and 17 are both without degree and in-degree 0, and there are two isolated vertices in the network indicating the network has five components with density score of 29/380 = 0.0763158. Figure 2 shows community plot based on modularity clustering, first proposed by Newman and Girvan [7]. From this plot, we can see that this network has seven distinct community. Note that $M_1,M_2,...,M_7$ denote the number of community.

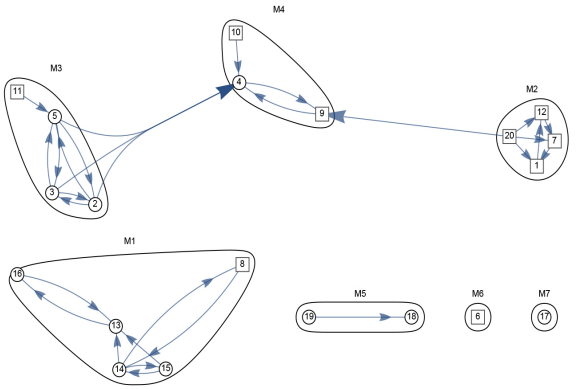

Figure 2: Community plot based on modularity clustering for CM programme

Software Engineering (SE) of Friendship Network

Similar information was gathered from 20 third-year undergrad students from SE at Universiti Malaysia Terengganu. The corresponding diagram representing personal sharing among 20 students is given in Figure 3. There are 12 female students and eight male students. The set of male students is $M = \{2,3,4,8,14,16,19,20\}$ and the set of female students is $F = V - M$. The total number of arcs in the network is 24, hence this graph has density score of 24/380 = 0.0631579.

There are five reciprocal pairs of arcs, hence this graph has reciprocity score of 10/24 = 0.416667. Out of five reciprocal pairs, there are three female and female pairs, and one male and male, and female and male pair. Hence, the number of arcs ending with a female is seven. Out of seven arcs, one is arc between male and female which is the student labelled by 2 sharing his problem with student labelled 1. Next, the number of arcs ending with male is 6 and there are two arcs between female and male, which is student with labelled 10 sharing her problems with student with labelled 2, while student labelled 12 shard her problems with student labelled 19.

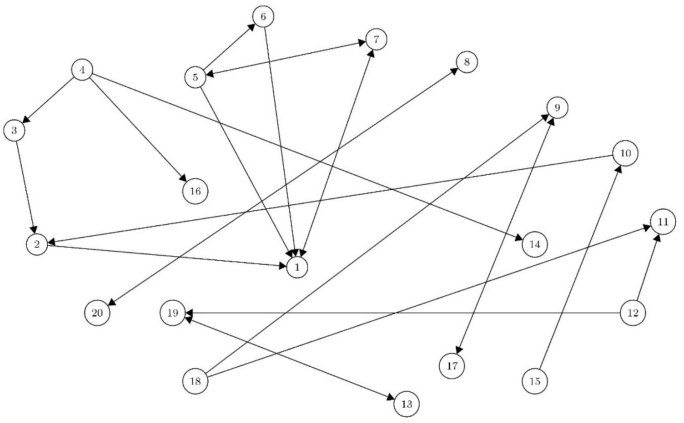

Figure 3: Directed graph based on in-degree and out-degree for SE programme

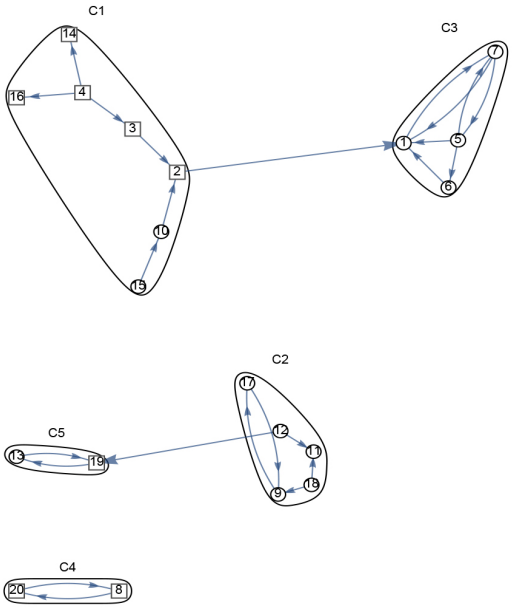

Figure 4: Community plot for 3rd year students of SE Engineering programme

For the network of SE students, their pattern in personal sharing is distributed fairly because there are some excellent networking opportunities between male and male, female and female and male and female. The most popular student is student labelled 1 with the highest in-degree of 4, indicating that she is a good listener and others approach her for personal sharing. There are three vertices with 0 out-degree but they have positive in-degree. Interestingly, these students seem to be a listener of his/her friend's problem but do not like to share problem with others. There is no vertex with 0 in-degree and 0 out-degree. That this means it that there is no isolated vertex in this social network, which is a good sign. Figure 4 shows community plot, which indicates five communities exist in this network. Note that M_1, M_2,...,M_5 denote the number of community.

CONCLUSION AND FUTURE WORK

This comparative study presents the reciprocity of social networks among third-year undergraduate students between two different programmes at Universiti Malaysia Terengganu. Based on our analysis, the pattern of personal sharing among two groups of students is quite different. CM students have five connected components, whereas SE students have three connected components, with each containing seven and five communities respectively. CM network is slightly denser and has slightly higher reciprocity than SE network. However, there are two isolated nodes in the CM network. This can be due to mathematics students preferring to solve mathematical problems individually. Personal sharing in these two groups is most popular between the same genders, which is the underlying nature of Asian culture. Most notable, female students are more comfortable sharing their problems with peers and are also good listeners compared to male students.

By further understanding the structure of these networks, the instructor has a better grasp of managing students in a strategic manner. For example, monitoring isolated students, providing extra resources to the communities

with less reciprocal ties. Future work includes the study of community formation based on race, gender, family background and their performance in class.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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REFERENCES

[1] T. Wey, D. T. Blumstein, W. Shen & F. Jordan. (2008). Social network analysis of animal behaviour: A promising tool for the study of sociality. *Animal Behaviour*, *75*, 333-344.

[2] I. McCulloh, H. Amstrong & A. Johnson. (2013). *Social network analysis with applications*. Hoboken, New Jersey: John Wiley & Sons, Inc.

[3] J. Moody. (2013). Race, school Integration, and friendship segregation in America. *American Journal of Sociology*, *107*(3), 679-716.

[4] E. Vaquera & G. Kao. (2008). Do you like me as much as I like you? Friendship reciprocity and its effects on school outcomes among adolescents. *Social Science Research*, *37*(1), 55-72.

[5] A. R. Rao. (1995). Reciprocity in marital and social networks: Illustration with Indian data. *Human Biology*, *67(*6), 887-904.

[6] A. R. Rao & S. Bandyopadhyay. (1987). Measures of reciprocity in a social network. *Sankhya Ser. A, 49*, 141-188.

[7] A. R. Rao. (1996). Reciprocity in a network: Theory and applications. In S. Arumugam, B. D. Acharya, E. Sampathkumar (Eds.), *Proc. of the National Workshop on Graph Theory and Its Applications* (pp. 129-144). Manonmaniam Sundaranar University, Tirunelveli. New Delhi: Tata McGraw Hill.

[8] B. Vasanthi, S. Arumugam & S. V. Nayana. (2016). Personal sharing in small groups – A case study. *Procedia – Social and Behavioral Sciences*, *219*, 108-112.

[9] M. E. J. Newman & M. Girvan. (2004). Finding and evaluating community structure in networks. *Phys. Rev. E.*, *2*(69), 15.

[10] R. U. Gobithaasan, N. S. Din, L. Ramachandran & R. Hasni. (2019). Boosting students' performance with the aid of social network analysis. *UMT Journal of Undergraduate Research*, *1*(3), 28-35.