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Understanding User Triads on Facebook

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***Abstract*—Contemporary approaches that analyze user behavior on online social networks only consider interactions among dyads, which are pairs of directly connected users. A large body of sociological work, however, suggests that mutual connections among users can influence their activities, leading to differences between two- and three-way interactions. This paper explores the dynamics of triads among Facebook users based on the wall posts from the New Orleans regional network. Initially, each connection is categorized as a close friendship or an acquiantance, contingent on the number of wall posts exchanged. Subsequently, the impact of different types of connections comprising triads is examined on the post volume and inter-post times. The analysis finds that these two properties are influenced by the number of close friendships constituting triads.**

I. Introduction

Online Social Networks (OSNs) have captured our imagination by offering a revolutionary medium for communication and sharing. These massive OSNs hold rich troves of information that can be mined and analyzed to understand patterns of social behavior in order to fulfill many objectives. For example, scientists explore this behavior to assess if sociological theories established in the offline world transcend to online networks. Moreover, commercial organizations leverage these patterns to determine how users exert influence and recommend products to each other and to run targeted advertising [**?**].

Longstanding sociological theories suggest that interactions differ fundamentally in a group of three as compared to a group of two people [**?**]. Brass *et al.* contend that an additional person can directly influence pairwise interactions by being in a position to convey information about the actions of another [**?**]. Similarly, Skvoretz *et al.* find that people in triadic relations, who serve in passive or bystander roles, can influence the development of hierarchies among its peers [**?**]. Triads in real-life social networks may also be influenced by the structural properties of their pairwise connections, including degree distributions, network density, and the local distribution of strong and weak dyads [**?**].

Most contemporary efforts that study online social networks consider dyadic relationships as the fundamental unit for analysis. However, from a societal perspective, triads is the smallest unit whose behavior is independent of the ties among the dyads [**?**], [**?**], [**?**]. Thus, recognizing this importance of triads, we study such three-way relationships among Facebook users. We first classify each pairwise connection as a "close friendship" or an "acquaintance" based on the number of wall posts among the participating actors. Subsequently, we identify different types of triads based on the constituent pairwise close friend and acquaintance relationships. We compare these different types of triads using two metrics, namely, post volume and inter-post times. Facebook wall posts, collected over approximately four years from the New Orleans regional network, provides the data for this study. Our analysis finds that these two properties of triads are influenced by the number of close friendships among their users.

II. Definition of Triads

We define a triad as three users whose connections form a complete graph. A connection is established between users P and Q if, at any time during the four-year period, P or Q posted a message on the other's wall. In this preliminary work, we do not consider triads containing structural holes [**?**], i.e., triples of users whose connections do not form a complete graph, or differentiate between triads composed of mutual dyads (e.g. a connection from P to Q and Q to P).

Intuitively, it can be expected that not all Facebook connections are created equal. Some connections will feature a large volume of activity between two good friends, while others may show little activity between two acquaintances. Therefore, we classify each connection as a close friendship or an acquaintance based on its strength, which we define in terms of the number of wall posts along the connection. To identify friendship and acquaintance connections, we first compute the mean number of posts along a connection, which for our data set is 3.24. We then designate a connection to be a close friendship only if the number of wall posts between the participating users exceeds this mean. Our definition of friendship requires strong activity only in one direction. In other words, if either P or Q exhibit behavior suggesting friendship (by posting at least 4 messages to the other's wall), we mark the relationship as a friendship. Furthermore, our friendship does not consider the cumulative number of wall posts along both directions (someone has to act like a friend for there to be a friendship). Thus, even if the total wall posts among P and Q exceeds the mean, P and Q are still acquaintances and not close friends if the number of posts in each direction is less than the mean.

Figure **??** illustrates how this threshold splits the connections between friendships and acquaintances. Using the mean

to split the connections is based on the following rationale. An "acquaintance" represents a very weak, and perhaps an even non-existent offline social tie among its two users. On the other hand, connections classified as "close friendships" have stronger ties among their participants as reflected by the higher number of wall posts among them. Splitting based on the mean labels approximately 80% of the connections as acquaintances. Given how users frivolously add connections to build social capital [**?**], we believe that this $80/20$ split of connections into acquaintances and close friendships is reasonable.

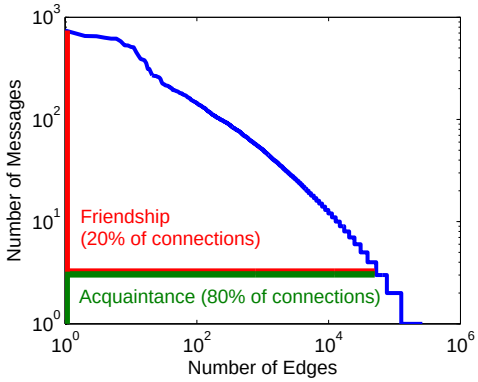

Fig. 1: Range of friendship connections

The classification of each connection defines four different types of triads based on the number of friendship edges they are composed of: *0-Friends*, *1-Friend*, *2-Friend*, and *3-Friends*. To assess the properties of these different types, we uniformly sampled $100,000$ triads from the New Orleans regional network. After eliminating duplicates and equivalents, our sample was reduced to $89,526$ triads. Figure **??** which shows the distribution of the different types of triads, indicates that approximately one quarter of all triads consist of three acquaintance edges, supporting the notion that acquaintance connections on Facebook are added abundantly, without discretion [**?**]. The percentage of *1-Friend* or *2-Friends* triads is greater than the percentage of all acquaintances or all close friends. The reasons for this may be tied to the behavior of the users in a triplet driven by the sentiment among its participants. *1-Friend* triads capture the notion that when P and Q are friends, if R is an acquaintance of Q it is likely to be an acquaintance of P as well. Similarly, *2-Friends* triads capture the idea that just because P is friends with Q and R, it may not be the case that Q and R are friends as well. Finally, we observe that because a minority of Facebook connections are close friendships, the total percentage of triads decreases as the number of constituent close friendships increases.

III. Comparison of Triads

In this section, we quantitatively compare different types of triads using two metrics, namely, the post volume and inter-post times. We also offer insights into the underlying social processes that influence these properties.

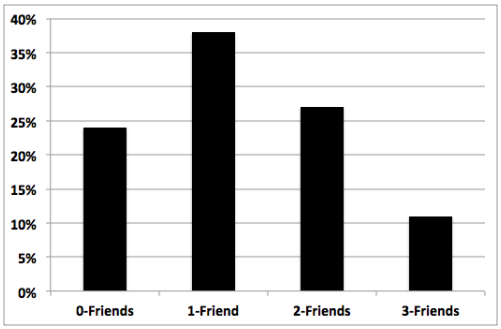

Fig. 2: Distribution of triad types

A. Post volume

Figure **??** shows the reliability function plotted on a log-log scale for the total number of wall posts in each type of triad. The trend for *0-Friends* triads is not shown, because according to our definition, the total number of posts in this type of triad cannot exceed 9. If this were not the case, the number of wall posts along at least one connection must be more than the mean number of messages, making it a close friend connection and the triad would no longer be a *0-Friends* triad. Table **??** summarizes the mean number of posts for the different types of triads, offering evidence of an increasing trend in the post volume with the number of close friendships.

We find that the volume of posts across every type of triad exhibits a linear trend on a log-log scale, which is the signature of a power-tailed distribution [**?**]. In a power-tailed distribution, the probability of witnessing a value greater than x is modeled as $R(x) \sim cx^{-\alpha}$ for $x > x_{min}$, where c is a constant, x_{min} is the value at which the power tail begins, and α is a parameter controlling the rate at which the probabilities of larger values decrease. Importantly, power-tails mean that the probability of observing values orders of magnitude larger than the mean is not negligibly small. In fact, as the sample size $n \to \infty$, if $\alpha < 2$ the sample distribution has infinite variance.

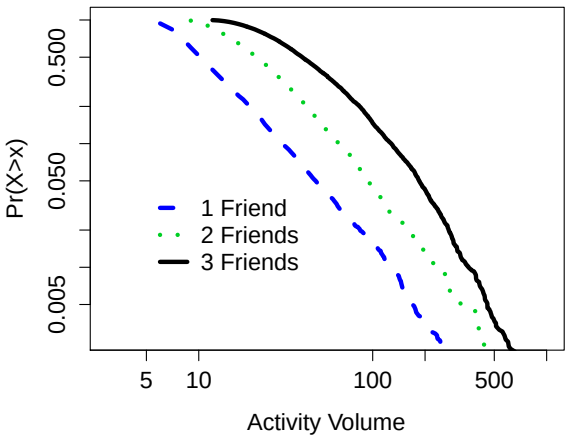

Fig. 3: Reliability function of post volume

For triads with a single close friendship, nearly the entire distribution is power-tailed with $\alpha = 2.53$. When two close friendships are included, the power tail starts at higher values, and α increases to 2.68. Finally, the power-tail for triads with three close friendships starts significantly later and $\alpha = 3.45$. The rising x_{min} and α values with the number of close friendships indicate that as the number of friendships in a triad increase the total variation in post volume decreases.

TABLE I: Mean number of posts for triad types

Type	Mean	Type	Mean
0-Friends	4.8	*1-Friend*	17.9
2-Friends	35.6	*3-Friends*	63.7

B. Inter-post times

We define inter-post time as the duration between successive posts along one direction of a connection of a triad. Figure **??** plots the distribution of inter-post times measured for the different types of triads. Unlike post activity which was significantly different depending on the number of close friendships involved, the distribution of inter-post times for *1-Friend* triads differs only moderately from the distribution for *2-Friends* triads. Table **??**, which presents a summary of the average time between posts for the different types of triads, confirms this observation. The table shows that as the number of close friendships in a triad increases, the mean inter-post time decreases. However, whereas the average number of posts double in going from *1-Friend* to *2-Friends* triads, the mean inter-post times reduce by only 25%. Similarly, in going from *2-Friends* to *3-Friends* triads, the average number of posts increases by approximately 80% but the reduction in the mean inter-post time is only 20%. Thus, the shorter inter-post times along the one or more close friendships dominate the longer times along the complementary acquaintances.

The sudden spike in the distribution for *0-Friends* triads at the one-year mark occurs from annual birthday messages commonly exchanged among Facebook users, which are also triggered and encouraged by Facebook alerts and reminders.

IV. Conclusions and Future Work

This paper identified different types of triads among Facebook users based on the strength of the connections that bind them. We compared these triads using two metrics related to wall posts; namely, post volume and inter-post times. We found that these two properties of the triads are influenced by the number of close friendships among their participants.

Our future work seeks to further classify triads based on whether a friendship among two users is bi-directional. Investigating whether the properties of triads approach those of dyads as the number of close friendships increases is also a concern of the future. We will also examine the content of the information exchanged among users in different types of triads to further determine the transferability of sociological theories to the online world.

TABLE II: Mean inter-post times (days)

Type	Mean	Type	Mean
0-Friends	173.4	*1-Friend*	48.4
2-Friends	37.5	*3-Friends*	30.2

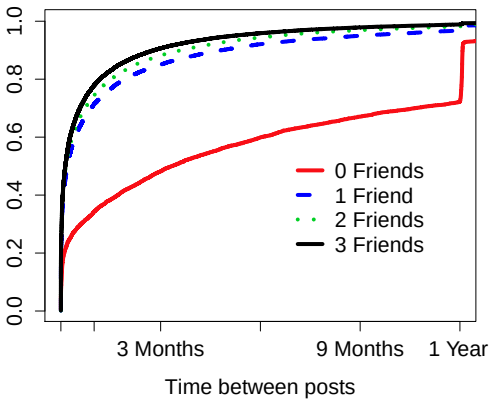

Fig. 4: Distirubiton of inter-post times

Acknowledgements

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