Determining Important Nodes in a Subgroup

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Key tools in social network analysis are the centrality measures, which are ways of deducing which nodes in a network are most important. In many real-world networks, nodes are divided by their attributes into subgroups. What was missing from classic social network analysis was a method for finding important subgroup nodes without losing the subgroup’s context in the entire network. The existing method simply removed the subgroup and analyzed it on its own. We have devised a new method for locating significant subgroup nodes in both the local and global sense. In a social network of both sexes, for instance, which women are most influential over other women, and which women are most influential over the men?

An Example Analysis

The network is the classic example from Lusseau et al. (2003) which consists of “friendship” ties between 62 bottlenose dolphins in Doubtful Sound. An inspection of the network and subgraph in Figure 1 reveals some concerns. There are male dolphins who have become isolates in the subgraph (Cross, Fork, and Zig). Furthermore, it would appear that SN96 should be quite important, as his removal would split the subgraph network into three disjoint pieces: the Topless group, the Beescratch group and the Bumper group. However, looking at the network as a whole, female dolphins hold these three groups of males together; SN96’s removal no longer causes the network to splinter.

One of the classic network measures that can indicate such splintering behavior is known as betweenness (Freeman, 1977). Our new method uses total network information, including ties outside the sub-group, to calculate this measure, but not in the same manner as calculations on the entire graph. We refer to this as subgroup betweenness. This results in a vastly different power ranking in our example. The top four dolphins by subgroup and traditional betweenness are represented in Figure 2. The traditional method overestimates the importance of SN96, PL, Beak, and Haecksel due to deleting relationships to female dolphins. What might this mean? For studying rumor spread among male dolphins, the subgroup rather than traditional approach to betweenness would be appropriate, assuming communications may spread through female dolphins as well. All gossip need not go through SN96; in fact Beescratch is more important in this regard. For a communicable disease affecting and carried solely by male dolphins the traditional approach is preferable; vaccinating SN96 is indeed a good idea. However, if females are also carriers then Beescratch is a better choice.

What about division into local and global influence? Subgroup measures are local measures, meaning a node is compared to only other nodes within the subgroup. We can form a global measure by comparing a node to all the nodes outside the subgroup. A representation of this applied to the measure known as closeness appears in Figure 3. The dolphins in the Topless group are generally closer in a global sense, while those in the Beescratch group are closer in a local sense. As a possible interpretation, a communication from Topless will spread through the female dolphin community quickly, while one from Beescratch will spread rapidly through the male community. If a particular message is highly important to female dolphins but not to males, Topless is an ideal messenger. Details may be found in the paper, Subgroup centrality measures: http://bit.ly/18mwJV6

References