Graph Theoretical Approaches to Privacy-Preserving Decentralized Systems

Guillermo Rodríguez-Cano
School of Computer Science and Communication
KTH - Royal Institute of Technology
Lindstedtsvägen 3, SE-100 44 Stockholm (Sweden)
gurc@csc.kth.se

Despite the popularity of on-line social networks (OSNs) and the increase of differing categories of OSNs, they still suffer from privacy- and security-related problems (e.g., user's lack of control on its own posted data or even its behavior when interacting with other users or the network itself).
Decentralized approaches have been proposed to decrease the risks that centralized alternatives (usually commercial[1]) such as Facebook[2], Google+[3] or Twitter[4] pose as a consequence of the their centralized data collection operations. We investigate how the modeling of such decentralized on-line social networks alternative affects the preservation of these important attributes, privacy and security.

As it has been proven that social networks differ from other types of networks [1], it seems of interest to model their virtual version, not only because of their resemblance with traditional networks such as those that make the Internet possible but also because of the different nature in the topologies that relationships between nodes in OSNs make possible as opposed to those that happen in computer networks due to the human behavior when mapping its bonds and interests of its life to the digital world.
Social Network Analytics (SNA) studies the social relationships in terms of graph theory, although usually representing the individuals as nodes and the relationships[5] that these individuals might establish among themselves as links or edges, but this perspective is not definitive because of the substantial variety of families of metrics that SNA has devised to characterize social networks (e.g., centrality).

In our work, we are aiming at extending the field of SNA with dynamic (e.g., temporal) and informational (e.g., expressiveness, heterogeneity of nodes and links) dimensions to inform the design of decentralized social networks in connection with privacy and security aspects as the modeling of such networks will have an impact on them.
We want to consider the possibilities that modeling based on hyper-graphs, a powerful abstraction of graphs, would offer to OSNs given that current strategies are largely based on graphs at a cost of losing expressiveness when representing information that would be preserved if other mathematical structures would be used instead.
Moreover, we would like to investigate the dynamic properties of social networks, taking into account both churn (joining and leaving nodes) and changes of links over time because the nature of social networks is not statics even though most research has focused on this direction.
Finally, examining social networks at their most atomic level (nodes and links) is as important as doing at their topological level because of the heterogeneity of relationships, resources and demands of each network component; but also because of the influence in the context of content and resources contribution, supply and demand heterogeneity on factors that may affect the evolution of the model (e.g., economics).

References

[1] Newman, M. E. J. and Park, Juyong, Why social networks are different from other types of networks, Physical Review E., Vol. 68 (3), pp. 036122+, 2003.

[1] Commercial in terms of mining the data provided by the participants of these social networks
[2] `http://facebook.com`
[3] `http://plus.google.com/`
[4] `http://twitter.com`
[5] Note that these relationships do not need to be necessarily at the affection level, for instance friendships, they might as well be organizational or professional, or they could even be depicted in terms of activities such as common hobbies.