Understanding motifs in complex graphs

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Scope: Motifs are recurring, significant patterns of interaction between sets of nodes, representing basic building blocks of networks. Motif analysis enables identification of important ties between members of social groups, offering insight into detection of anomalous behavior, prediction of missing (hidden) group structure and forecast of group future evolution.

Description: This demonstration showcases some of the research being carried out as part of Project 6 Task 2, "Understanding group behavior through motifs", in the BPP 2018 research program. The demonstration will be linked to the DAIS ITA scenario, specifically Phase 3 and Vignette 1 and will draw together collaborative research and results from across this task.

Network motifs refer to recurring, significant patterns of interaction between sets of nodes. While an external network of interest may not be fully visible to the coalition, motifs represent important atomic substructures more likely to be visible, from which inferences can be made.

This demonstration shows the progress that we have made against two of the three subtasks in this research (the third subtask has not yet been addressed in the research so cannot be demonstrated, however the demonstration infrastructure will continue to be developed throughout the research program, with the third subtask being integrated as soon as results are available).

These research subtasks are:

1. Comparisons of Metrics and Models of Multiple Social Networks.
2. Dynamic Motifs in Dynamic Networks.

For the first subtask we demonstrate a number of social networks and the results of network motif analyses against these networks. Interpretation of the results is given where possible, along with the ability to explore the networks and set various filters to highlight or suppress different motifs.

For the second subtask we present our initial work relating to the concept of T-motif (temporal motif) where network motifs are extended to take into account the development of the network over time, extending initial work in this area. The demonstration provides an interactive network environment with temporal controls, allowing the analyst to explore the network at various stages during the lifecycle. The motif distributions can be explored at each time point as well as seeing the results of the T-motif analysis.

In both cases the demonstration showcases the potential for a rich interface to explore complex graphs and network motifs to help the human analysts understand the insights that can be gained from this network motif information. For example by guiding the user through the differences between motifs that characterize string-like connections vs those that show more centrally connected hubs, and to explain the behavioral differences that can arise as a result of these as well as different mechanisms for attacking or bolstering such networks. The demo will also attempt to show the inferential potential when applying these techniques to a partial network to enable prediction of the wider network properties.