Understanding motifs in complex graphs

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Network Motifs

Motifs are recurring, significant patterns of interaction between sets of nodes, representing the basic building blocks of graphs.

Motifs capture substructures that define mesoscopic information about the larger graph.
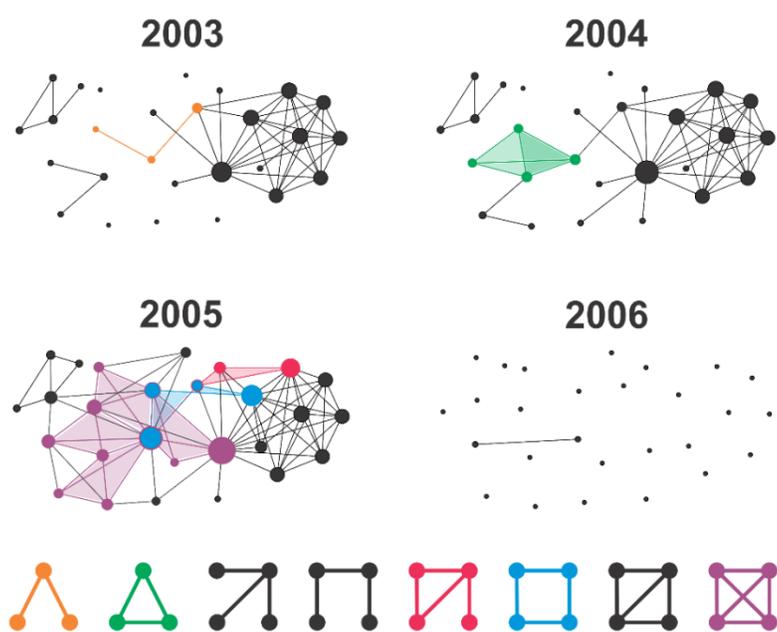

Figure 1: Example network analysis: evolution of terrorist network of 2005 Bali attack with marked selected triadic and tetradic undirected motifs originating from a particular node

Motif analysis identifies occurrences that are more expected than in random graphs with the same structural features.

Motif investigation platform

This demonstration shows the beginnings of a network motif investigation platform to improve the ability to interact with small but complex graphs. Specifically to:

- Support exploration by human users
- Enable computation and automated analysis to reduce exploration time
- Support temporal analysis and multi-partite graph analysis

The demonstration falls into two main aspects: network visualisation (via browser-based graph frameworks), and analytic methods (via Python, R and Jupyter notebooks).

Research sub-tasks

The research is focused into two main tasks, both of which are explored in this demonstration:

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

Datasets

We are investigating, and have published results for, a number of datasets. Each of these are available in the demonstration platform, which is designed to operate across any small complex graph and could be extended to operate on larger more complex graphs if needed.
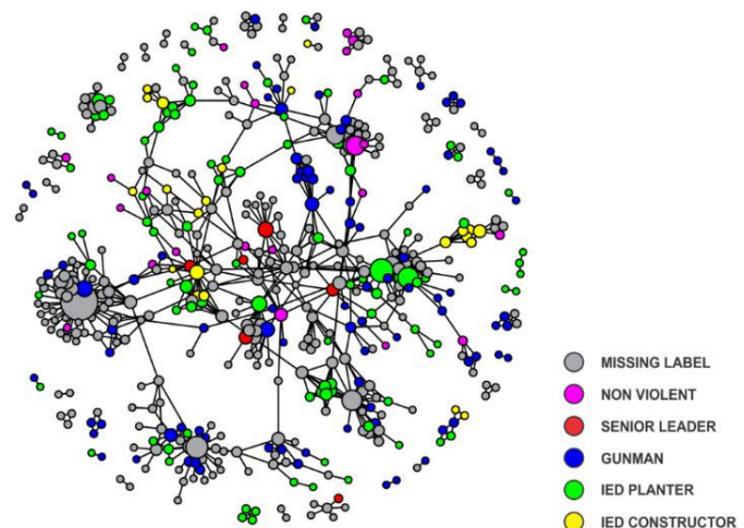

Figure 2: Visualization of the Provisional Irish Republican Army network in the period 1981-1989. Node colors denote roles individuals played in PIRA operations.

Military relevance

Our work relates closely to phase 3, vignette 1 of the DAIS ITA scenario: Person Of Interest (POI) tracking.

We aim to develop motif based indicators capable of addressing multiple stages of the POI tracking task:

- Identify POI through properties of their social network
- Characterize daily life patterns of POI environment
- Identify anomalous behaviour

We plan to assess utility of our approach using military relevant datasets (terrorist networks, crime organization networks, hacker chats).

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