The Complexity of Terrorist Networks

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1.1 Introduction

Complexity science affords some novel tools for examining terrorism, particularly network analysis and NK-Boolean fitness landscapes. The following paper explores various aspects of terrorist networks which can be illuminated through applications of non-linear dynamical systems modeling to terrorist network structures. Of particular interest are some of the emergent properties of terrorist networks as typified by the 9-11 hijackers network, properties of centrality, hierarchy and distance, as well as ways in which attempts to disrupt the transmission of information through terrorist networks may be expected to produce greater or lesser levels of fitness in those organizations.

1.2 Mapping Terrorist Organizations

One of the most useful tools for mapping terrorist organizations has been network analysis. A variety of maps and mapping techniques have emerged in the post 9-11. World. One of the earliest and most influential maps was developed by Valdis Krebs (Krebs, 2001) shortly after 9/11 (Figure 1):

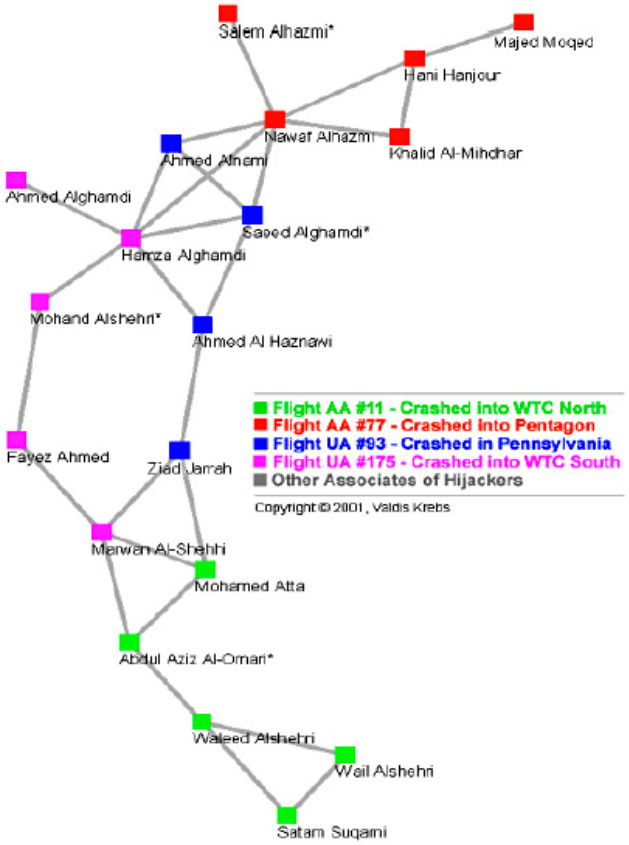
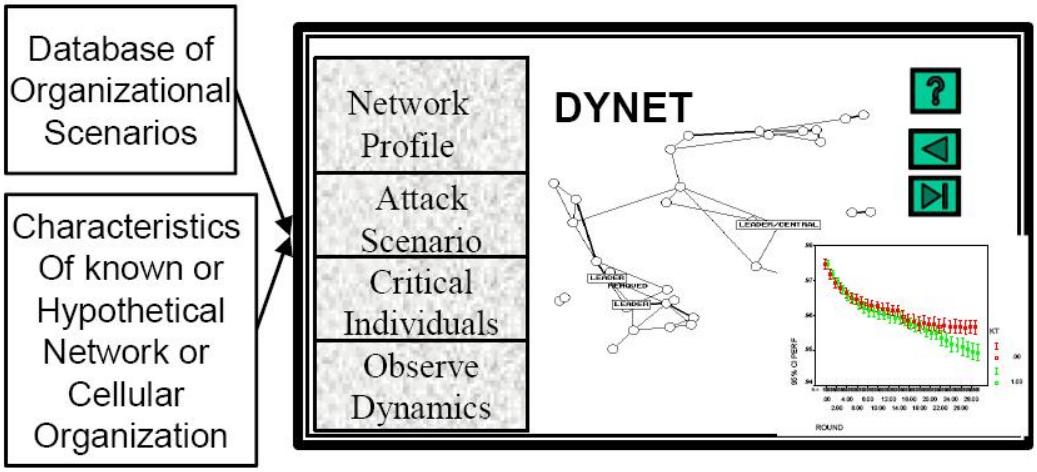


Figure 1: Valdis Krebs Mapping of the 9-11 Hijackers' Network

This map yields a number of interesting properties. Using measures of centrality, Krebs' work analyzes the dynamics of the network. In this regard, he also illuminates the centrality measure's sensitivity to changes in nodes and links. In terms of utility as a counter-intelligence tool, the mapping exposes a concentration of links around the pilots, an organizational weakness which could have been used against the hijackers had the mapping been available prior to, rather than after the disaster, suggesting the utility of developing these tools as an ongoing mechanism for combating terrorism.

2.1 Carley's DyNet Model

The most developed version of these tools is probably the Dynamic Network Analysis (DNA) model developed by Carley et al (2002a, 2002b, 2003).



DYNET: A desktop tool for reasoning about dynamic networked and cellular organizations.

Source: Dynamic Network Analysis, Kathleen M. Carley, Institute for Software Research International, Carnegie Mellon University

Models of the 9-11 Network, the Al Qaeda network which bombed the U.S. Embassy in Tanzania and other terrorist networks also show a characteristic emergent structure, known in the vernacular as "the dragon". One element of this structure is relatively large distance between a number of its covert elements (Fellman et al, 2003, 2004; Clemens and O'Neill, 2004, Carley et al, 2001,2002a,2002b,2003, 2004; etc.) which suggests that some elements of the network, particularly certain key nodes (Butts, 1999, 2000, 2001, etc.) may be relatively easy to remove through a process of over-compartmentation or successive isolation, thus rendering the organization incapable of transmitting commands across various echelons.

3.1 Symmetries and Redundancies

On the other hand, the 9-11 Network also demonstrates a high degree of redundancy as illustrated by the following diagram (Fellman and Strathern, 2004):

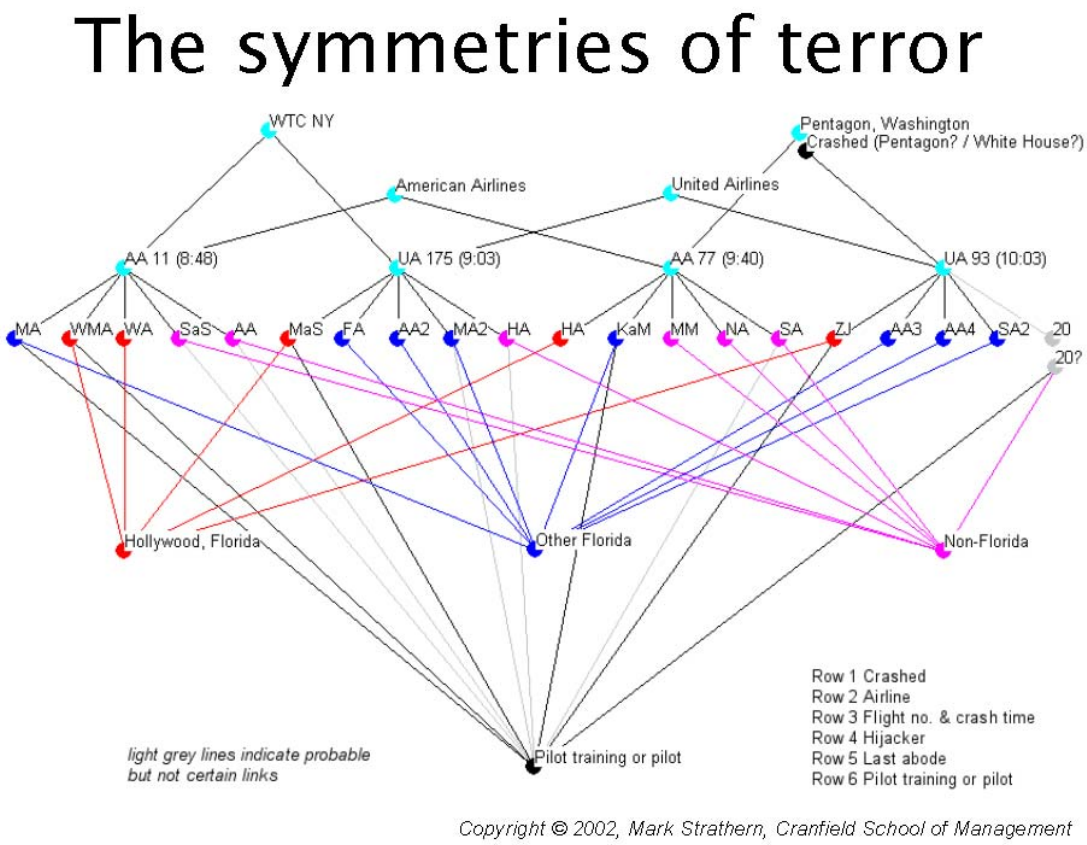


Figure 3: Symettries of the 9-11 Hijackers Network

This mapping suggests, in turn, that while the network may be highly distributed, the redundancies built into it suggest cohesion at a number of levels as well as an hierarchical organization. A number of systems analysis tools have been developed to deal with the problem of covert networks and incomplete information (Carely and Butts, 1997; Butts, 2001, 2003a, 2003b; Clemens and O'Neill, 2004).

4.1 Isolation and Removal of Nodes

DNA, for example, provides a number of insights into what happens when leadership nodes are removed from different kinds of networks, yielding very different kinds of results depending upon whether the network is cohesive or adhesive (Carley et al, 2003, 2004). In particular, Carley et al demonstrate how isolation strategies (also suggested in Fellman et al, 2003, 2004) will yield different results based on the nature of the network involved (Carley et al, 2004):

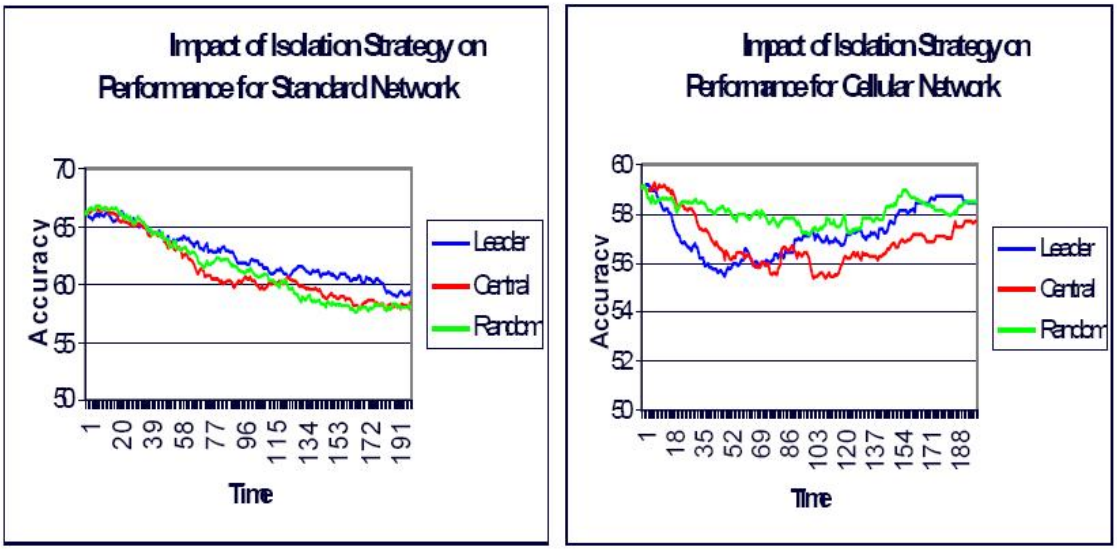


Figure 4: Impact of Isolation Strategies on Cellular vs. Standard Networks (Carley, 2003)

5. 1 Terrorist Networks and Fitness Landscapes

The dynamic NK-Boolean fitness landscape developed by Stuart Kauffman (Kauffman 1993, 1996, 2000) for evolutionary biology has attracted increasing interesting in a number of fields involving social phenomena. In particular, it offers a substantial degree of promise in providing new models for understanding and evaluating the strategic performance of organizations (Ruigrok and Wagner, 2006; Caldart and Ricardt, 2004). An agent-based simulation conducted in 1999 and 2000 by Pankaj Ghemawat and Daniel Levinthal (Ghemawat and Levinthal, 2000) using an NK-Boolean fitness landscape framework for strategic management decision-making, has yielded some results differentiating the effects of interpolating non-optimal values into the decision-making processes of hierarchical vs. interdependent organizational structures which have some interesting results with respect to isolation and disinformation operations against terrorist networks. When they explore the difference between an optimal preset of policy configurations between hierarchical, central and random simulation arrays they find that disrupting lower order policy variables is likely to have little relative effect on the robustness of the organization as compared to the mis-specification of higher order values, particularly in hierarchical organizations.

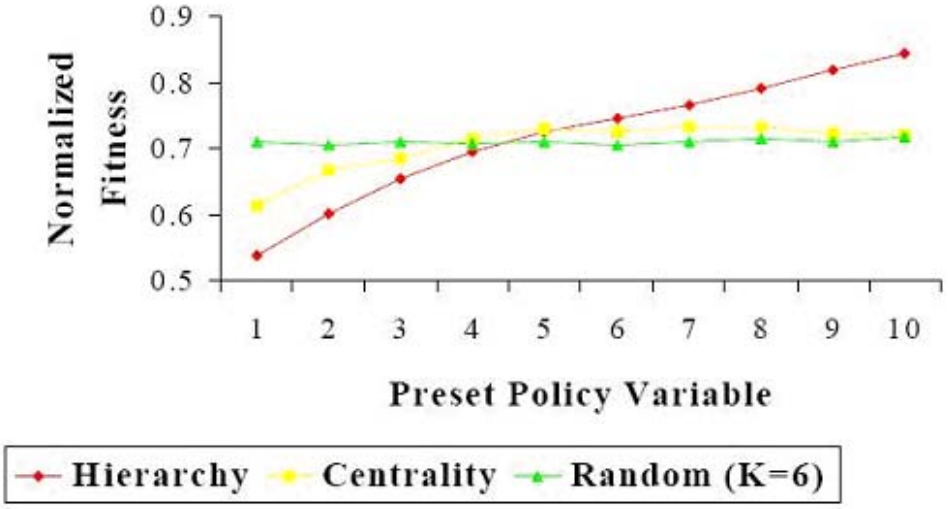


Figure 5: The effects of history, wrongly set decisional variables (Ghemawat and Levinthal, 2000)

In dealing with terrorist organizations, which are primarily hierarchical in nature (Sageman, 2004), what this finding says is that disinformation is a useful tactic (or strategy) only if it succeeds in influencing one of the key decisional variables. In other words, disinformation at the local level is unlikely to have any lasting impact on terrorist organizations. This finding also challenges the institutional wisdom of assigning case officers in the field to this type of counter-terrorism operation (Gerecht, 2001; Codevilla, 2004b).[1] In fact, from an operational point of view, the hierarchical nature of terrorist organizations means that there may be something of a mismatch in the entire targeting process. As Ghemawat and Levinthal note, "Less central variables not only do not constrain, or substantially influence the payoff of many other choices, but they themselves are not greatly contingent upon other policy choices. Being contingent on other policy choices facilitates compensatory shifts in policy variables other than the one that is preset. As a result of the absence of such contingencies, the presetting of lower-order policy choices is more damaging to fitness levels under the centrality structure." (p. 27)

6. 1 Conclusion

Terrorist networks are complex. They are typical of the structures encountered in the study of conflict, in that they possess multiple, irreducible levels of complexity and ambiguity. This complexity is compounded by the covert, dynamic nature of terrorist networks where key elements may remain hidden for extended periods of time and the network itself is dynamic. Network analysis, agent-based simulation, and NK-Boolean fitness landscapes offer a number of tools which may be particularly useful in sorting out the complexities of terrorist networks, and in particular, in directing long-run operational and strategic planning so that tactics which appear to offer immediately obvious rewards do not result in long term damage to the organizations fighting terrorism or the societies which they serve.

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[1] Ghemawat and Levinthal test this another way and come to essentially the same conclusion: "Another striking feature of this set of simulations concerns how few of the optima with preset mismatches constitute local peaks of the fitness landscape. Given the importance of configurational effects, one might reasonably conjecture that constraining one variable to differ from the global optimum would lead to the selection of a different, non-global, peak in the fitness landscape. However, Figure 9 indicates that this is relatively uncommon except as one turns to presetting the least important variables under the hierarchy and centrality structures." (pp. 28-29)

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