



### *Statistical Changes: Actor Oriented Models to Detect Significant Behavioral and Social Changes Over Time.*

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#### **Objective:**

Our research strives to develop statistical methods to model longitudinal networks, detect change over time, and measure the impact of ergodicity on longitudinal network analysis. Detecting dynamic changes over time from an SNA perspective, may signal an underlying change within an organization

#### **Approach:**

Social network analysis (SNA) has become an important analytic tool for analyzing terrorist networks, friendly command and control structures, arms trade, biological warfare, the spread of diseases, among other applications. A new method is proposed to simulate instances of a network that is similar in properties to the original data. Several social network measures are evaluated using the newly proposed simulation technique to determine the measure's ability to account for relational dependence in social networks and identify their underlying distribution. The Neyman-Pearson most powerful test of simple hypotheses is extended as a cumulative sum statistical process control chart to detect network change over time. In addition, time-series, spectral analysis, wavelets, and Bayesian classifiers will be explored for their ability to detect changes in a network over time. The performance of these newly proposed methods are compared to demonstrate their probability to detect changes of varying types and magnitudes. This new approach will be demonstrated on multiple different real-world data sets, as well as simulated data. The results of this project will include new methods to detect network change even with different levels of uncertainty inherent in the data. The ability to systematically, statistically, effectively

and efficiently detect these changes has the potential to enable the anticipation of change, provide early warning of change, and enable faster appropriate response to change.

#### **Impact:**

Prior to an organization conducting any operation, whether terrorist or friendly, experiences a fundamental change in their organizational behavior and communication as they plan and resource the operation. Rapid change detection may offer analysts the ability to detect the organizational change prior to the operation reaching successful culmination. In other words, this research has the potential to alert the military to enemy or terrorist activity prior to the successful completion of an attack. It can also alert military commanders to potential challenges in friendly command and control structures in time to positively influence the outcomes. Finally the statistical methods developed will make broader contributions to the field of network science.