Opportunity Title: Predicting Social Network Dynamics Using Agent-Based Models
Opportunity Reference Code: ICPD-2020-11

Organization Office of the Director of National Intelligence (ODNI)

Reference Code ICPD-2020-11

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If you have questions, send an email to ICPostdoc@orau.org. Please include the reference code for this opportunity in your email.

Application Deadline 2/28/2020 6:00:00 PM Eastern Time Zone

Description **Research Topic Description, including Problem Statement:**

The application of Graph Theory can model a variety of real-world networks, including cyberspace, geospatial networks, and both interpersonal and online social networks. The advent of Facebook and similar social media platforms has expanded the definition of social networks, and has precipitated interesting emergent social dynamics. Modeling these dynamics would provide insight into how large social networks evolve over time, and inform strategies to influence social network cohesion or disintegration. In one possible approach, a trigraph can represent three interpersonal relationships (edges) between three individuals (vertices). Social dynamics would suggest that, if the assigned valence ("sentiment") of any edge is represented by either +1 or -1 (positive or negative interpersonal relationship), a trigraph will equilibrate such that any negative relationship will either become positive, or one of the remaining positive relationships will become negative, thus causing trigraph disintegration. The driving force is social pressure within the trigraph, leading to two possible outcomes: either trigraph cohesion (reintegration of the negative relationship), or disintegration (ejection of one group member). By expanding this agent-based model to any n-sized social network of interconnected trigraphs, the cohesion or disintegration of the larger network can be modeled. By varying parameters such as disintegration verses reintegration probabilities, network density and size, and initial network states; one should be able to predict the properties of an emergent network set, thus providing insight into real-world social network dynamics, including strategies to influence these dynamics.

Example Approaches:

There are different ways that this research can be approached; versatile approaches are encouraged. Variation of the initial states, including social network size, shape, and density; clique sizes; the initial placement and density of negative edges; and the number of iterations in the network evolution process, are all expected to have an impact on the resultant set of output networks. Researchers could focus on varying these parameters to develop a comprehensive model, and fitting that model to real-world social networks. Alternative methods to instantiate subgraphs for perturbation (like the trigraph example) could also be considered.

Proposals could consider one or more of the following:

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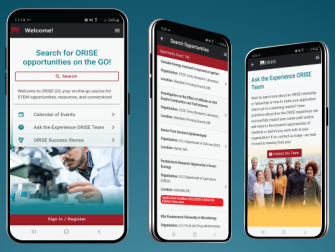
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- Comprehensively, how can agent-based models be applied to social network analysis, and more specifically, modeling network evolution?
- Are there resultant graph metrics (e.g., centrality metrics, continuity, etc.) that are more or less sensitive to different initial states? Are there metrics that are correlative or predictive of network disintegration or cohesion?
- Real-world networks will include random instantiation and deletion of individual relationships (either positive or negative). Can a convergent model be developed that accounts for these stochastic effects?

Relevance to the Intelligence Community:

Understanding social network dynamics would provide great insight into different strategies to influence network cohesion or disintegration, and how these phenomena affect information propagation. As denial and deception operations continue to affect the public more broadly though the interconnectedness of social media, it becomes imperative to understand how these operations can be effectively modelled and mitigated. Thus, research in this area will significantly affect the development of future operational targeting and counterintelligence applications.

Key Words: Stochastic, Social Media, Networks, Graph, Community, Dynamics, Subgraph, Agent-Based Model, Game Theory

Qualifications

Postdoc Eligibility

- U.S. citizens only
- Ph.D. in a relevant field must be completed before beginning the appointment and within five years of the application deadline
- Proposal must be associated with an accredited U.S. university, college, or U.S. government laboratory
- Eligible candidates may only receive one award from the IC Postdoctoral Research Fellowship Program

Research Advisor Eligibility

- Must be an employee of an accredited U.S. university, college or U.S. government laboratory
- Are not required to be U.S. citizens

Eligibility Requirements

- **Citizenship:** U.S. Citizen Only
- **Degree:** Doctoral Degree.
- **Discipline(s):**
  - **Chemistry and Materials Sciences** (12)
  - **Communications and Graphics Design** (2)
  - **Computer, Information, and Data Sciences** (16)
  - **Earth and Geosciences** (21)
  - **Engineering** (27)
  - **Environmental and Marine Sciences** (14)
  - **Life Health and Medical Sciences** (45)
  - **Mathematics and Statistics** (10)
  - **Other Non-Science & Engineering** (2)
  - **Physics** (16)
  - **Science & Engineering-related** (1)
  - **Social and Behavioral Sciences** (27)

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