Exploring Fuzzy Cognitive Maps for use in a Crisis-Management Simulation

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Keywords: Fuzzy Cognitive Maps, Intelligent Aid, Crisis Management, Teamwork, Situation Awareness

Human cognition has become substantially strained due to the enormous amount of information present, making it difficult to achieve high situation awareness. For example, decision-makers can access large quantities of information, most of which is irrelevant or immaterial, that must be distilled in a timely manner. The situation becomes even more complicated when a team or team of teams is involved, as teamwork introduces layers of coordination and collaboration that are necessary to achieve a goal. Activities performed at these layers can be dubious because team members may not share the same situational awareness or the teams may be overwhelmed with information, relevant or otherwise. The purpose of this abstract is to initially describe the design of an intelligent aid that assists users at the team level of operations and to allow timely execution of decisions.

Crisis management offers a real world domain that serves as an excellent area for examining team cognition and situational awareness. The work found within this domain is highly emergent and complex, and requires people to work in teams interacting through various levels of collaborative and communicative technologies. The complexity of this domain necessitates a team-based approach; teams allow members to share the workload, monitor the work behavior of other members, and develop and contribute expertise on subtasks (Mathieu, Heffner, Goodwin, Salas, & Cannon-Bowers, 2000; Cooke, Salas, Cannon-Bowers, & Stout, 2000). A crisis-management simulation called NeoCITIES was developed to study these characteristics and examine team cognition and team performance within a distributed environment (Jones, McNeese, Connors, Jefferson, & Hall, 2004). At a basic level, NeoCITIES simulates a terrorist attack on a community. Participants control various emergency service teams (e.g., police, fire, and hazmat teams), playing the role of decision-makers and assigning resources to handle events. The participants’ goal is to successfully respond to events in a timely manner, thus preventing a city-wide catastrophe. For this effort, the simulation will be used to examine how information is accessed and how intelligent technology can support the effectiveness of teams.

A fuzzy cognitive map (FCM) is a model of the cause and effect relationships that define a complex system (Perusich, 2001; Kosko, 1987). Unique to FCMs is their ability to incorporate attributes as qualitative states, rather than numerical characteristics. A FCM is a transformational grammar used to model complex systems with emergent and non-linear qualities. In a sense, the FCM provides an adaptive structure that affords qualitative reasoning as assessed from the current levels or states of a complex system. Perusich indicates that the reasoning characteristics of a FCM make it a significant decision support aid for team decision makers (Perusich & McNeese, 1998).
The primary goal for this study is to measure the impact of an intelligent aid designed to assist decision-making and resource allocation in distributed teams. This will be evaluated by observing the conduct of teams in the NeoCITIES simulation given the presence or absence of the intelligent aid.

The design of the intelligent aid includes a fuzzy cognitive map that monitors the team performance and progress throughout the entire simulation. The aid only has information that has been presented to the teams and it is designed to operate in the following manner:

- **Case 1:** Provide assistance to the teams during high cognitive loads (information overload). The assistance will come in the form of suggesting to the teams to send more resources (a generic response) or suggesting sending more resources of a particular type (a more specific response).
- **Case 2:** Oversees the information that has been given to each user and it provides suggestions when one user has information that is highly material to another user.
- **Case 3:** Interactive aid; user can request assistance from the aid and it will provide a COA consisting of sending a specified quantity of a particular resource.

The following outcomes are predicted as a response to the primary research goal of the present study: to introduce an intelligent aid using fuzzy cognitive maps to support decision-making and teamwork in a crisis-management simulation. First, the intelligent aid should effectively detect and gauge instances of cognitive overload in distributed teams, and then assess team progress and suggest pertinent courses of action for successful completion of the scenario. Second, the aid used should autonomously track the information presented to distributed teams, assess the relevance and utility of that information to each of the sub-team’s current problem of interest, and then prompt teams to include potential relevant information into their decision-making or share that information with the parties involved. Third, users should have the ability to query the intelligent aid as a way of utilizing pertinent information to formulate strategic knowledge about the underlying scenarios within their problem space. In this case, the IA should suggest plausible methods for addressing high severity events, as well as potential courses of action for uncovering and dealing with clandestine operations.

**References**


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