Framework for the Analysis of Coordination in Crisis Response

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Abstract
Social Media play a critical role during crisis events, revealing a natural coordination dynamic. We propose a computational framework guided by social science principles to measure, analyze, and understand coordination among the different types of organizations and actors in crisis response. The analysis informs both the scientific account of cooperative behavior and the design of applications and protocols to support crisis management.

Author Keywords
Emergency Response, Coordination, Organizational Sensemaking, Cooperative behavior, Semantic Analysis, Distributed Decision Making

ACM Classification Keywords
H.1.2 [MODELS AND PRINCIPLES]: User/Machine Systems—Human factors

General Terms
Design, Theory, Measurement

Introduction
Social media completely revolutionize the creation, distribution and consumption of information. The function of social media such as Twitter in crisis response is particularly salient in a number of recent

crises, such as the Haiti (2010) and Japan (2011) earthquakes, as well as Hurricane Irene (2011). While social media enable coordination among the residents of a threatened community, the message traffic is not directly useful to the organizations that can provide service and aid. Two challenges to the exploitation of social media for emergency response are the volume of message traffic and the inability of the resource-limited, formal emergency response organization to respond to every hint of need. But the new paradigm also presents the opportunity to enhance the effectiveness of resource allocation, by tapping otherwise unused resources and distribution processes in the community at large. The combination of challenge and opportunity heightens the need to study and build models for effectively coordinated operations of emergency response organizations, community resource providers and resource seekers.

Our dictionary [1] definition of coordination is *the harmonious functioning of parts for effective results.* We note the entirely proper absence of organizational and intentional properties in this definition. Coordination can occur top-down and intentionally, in the well-defined hierarchy of a formal organization. But, coordination also occurs bottom-up and fortuitously, among a loosely coupled set of independent actors. For example, a Twitter business conversation between a customer and a vendor evolved into a safety check during the California mudslides in 2009 (refer figure 1). We believe that orthogonal organizational properties shape coordination behaviors, and potential coordination challenges, within and between cooperating agencies. In the remaining paper, we describe our approach with related work and then conclude.

[1] From Merriam-Webster, http://www.merriam-webster.com/dictionary/coordination

Approach

To ground our recommendations for the design of applications and protocols to support crisis management in a scientific account of cooperative behavior, we propose a comprehensive framework (refer figure 1) for data collection and analysis:

A.) Domain Knowledge driven data collection and Semantic Analysis to extract key nuggets: In the absence of pre-specified communication protocols in crises, the social data from various platforms (microblogs, blogs, forums, SMSs etc.) provides a deluge of raw data, not all of which is relevant to emergency response. This deluge challenges the identification of needs, resources and emergent coordination in the community. Our analysis leverages a detailed event model, mined from community knowledge bases such as Wikipedia to identify and interpret contextually relevant social data. Semantic analysis techniques can be applied to identify and extract resources (important entities), actors (people and organizational affiliation) and key information for actions- spatial and temporal information. Moreover, Semantic analysis helps in extracting relationships between the key nuggets [6,7,10,14].

B.) Coordination analysis: We argue that detecting emergent coordination is key to maximizing the efficient deployment of limited emergency response resources. We categorize organizations based on degree of pre-established communication protocols, defined reporting hierarchies and explicit purpose.

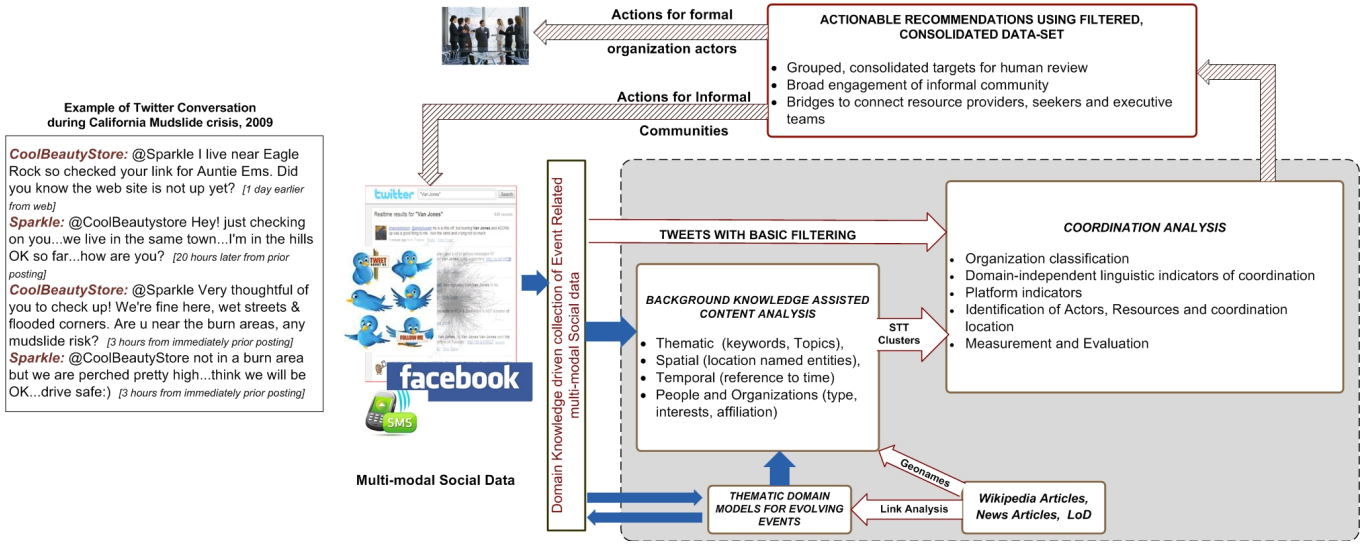

Figure 1 Coordination analysis framework and example Twitter conversation. [*STT Clusters: Spatio-Temporal-Thematic Information Clusters]

For instance, Federal Emergency Management Agency (FEMA) is a *Formal organization*, local churches are *Informal* and the Red Cross is a *Hybrid*. Formal organizations, whose raison d'etre almost completely reflects emergency response, likely define and impose a coordination protocol. Informal organizations arise from agencies with independent purposes, such as manufacturing, veterinary care, restaurant services, special interest clubs, and religious congregations, which lack a coordination protocol. Instead, they have common knowledge of community leaders and resources. Hybrid organizations, such as the Red Cross, have knowledge of the formal system structure and defined procedures. However, because hybrids import external labor from surrounding communities, they lack the common knowledge that grounds the informal organizations.

Exploitation of social media by the formal organization requires an analysis of informal, independent organizational communities.

We suspect that recommendations that hinge on imposing low-level communication templates on informal organization will fail because they are brittle under stress and non-standard circumstances [12]. Alternatively, we focus on detecting and extracting patterns of coordination in communications within the informal organization. The multi-layered approach to the analysis of communication characteristic of contemporary psycholinguistic theory supports our approach [1,2,8]. Properties of an exchange, including opening and closing phrases, anaphora and deixis reveal the existence of coordination, and hence the emergence of a new informal community to effect a

result. We have developed and tested promising domain-independent heuristics based on these properties using Twitter conversations during the 2011 Japan and New Zealand earthquakes. A Signal Detection Theory analysis [13] quantifies the diagnostic success of these heuristics. Platform assisted conventions like # (hashtags), @ (for addressing/ mentioning another user) do mediate the detection of coordination, but do not function effectively on their own. When combined with user profiles and spatial-temporal nuggets, we can highlight pockets of need and coordination for further review by the formal organization.

Conclusion

We propose a framework to identify and analyze relevant coordination in the informal community. We leverage an event-specific domain model to identify relevant exchanges, followed by domain-independent language analysis of emerging informal organizations. This framework filters information for the formal organization to enhance response time and the deployment of scare resources.

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