Online Information Behaviors During Disaster Events: Roles, Routines, and Reactions

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Abstract

Social media and Internet-based messaging systems are increasingly important platforms for risk communication. A global audience turns to these tools to seek, disseminate, and curate time-sensitive, event information during periods of crisis. Moreover, emergency responders report adopting these tools to augment their typical public information functions. Here, we use unsupervised machine learning methods and text analysis to explore online communications from a set of state and Federal emergency management-related organizations over a period of 15 months. We compare communication during routine, non-event periods with communication during significant disaster events in order to evaluate differences in the roles these organizations play. Findings indicate that communications from emergency management organizations align based on functional roles during routine situations, but during crisis events communication strategies converge on a mutual objective. These results have important practical consequences for organizational learning within this environment and could inform social media policies for emergency responders.

1 Background

Social media and other Internet-based communication technologies have become critical components of emergency preparedness, response, and recovery. When crises occur these platforms are appropriated for many different purposes including but not limited to: exchanging emergency warnings/alerts; seeking, curating and disseminating event-related information; checking in with family and friends; and propagating misinformation (Palen, 2008; Monroy-Hernández et al., 2012; Fraustino et al., 2012). Despite widespread use of social media during crises, both by the general public and government officials, research on information and communication behaviors in this context is still in its infancy.

While existing work addresses important questions about the use of social media during crisis events (Starbird and Palen, 2013; Starbird et al., 2010; Monroy-Hernández et al., 2012, 2013; Liu et al., 2008; Earl et al., 2013), most prior studies are retrospective and case study-based, considering only data collected after a particular crisis has occurred. Moreover, there is a strong tendency for researchers to focus on the behaviors of the public. Studies of the behavioral patterns of official emergency responders are limited, though some notable exceptions exist (Sutton et al., 2013; Carter et al., 2014). Here we directly address this gap. In particular we analyze a longitudinal dataset of online communication from a national sample of official emergency management-related Twitter accounts. We compare communication behaviors during routine, non-event periods with those during major crisis events in order to evaluate differences in the roles these organizations play. This work has important consequences for emergency preparedness, response and recovery strategies and could potentially reduce human and economic losses, and mitigate long-term damage to disaster affected communities (Tierney, 1985; Mileti, 1999; Palen et al., 2007; Sutton et al., 2012).

We investigate longitudinal trends in communication by official emergency management-related organizations on the popular microblogging service Twitter. We begin by quantifying the information space spanned by message content. What do these agencies communicate about on Twitter? Moreover, we examine the temporal dynamics of these topics in relation to exogenous shocks - disaster incidents. How do communication practices during preparedness and response phases differ? We seek to fill a gap in the growing field of crisis informatics by offering a systematic investigation of informational strategies over time.

2 Data

The data used here come from the Hazards, Emergency Response, and Online Informal Communication (HEROIC) Project[1] (Butts et al., 2011). A total of 216 Twitter accounts were identified as part of this project, encompassing national agencies like the Federal Emergency Management Agency (FEMA) and the Centers for Disease Control (CDC), as well as state-level accounts representing state governments, law enforcement, public health and public safety agencies, divisions of the National Guard and Coast Guard, and personal accounts of governors.The Twitter REST API was used to collect all public (non-private) messages (tweets) posted by these accounts over the 15 month period from June 1st, 2010 through September 21st, 2011. A total of 171,729 tweets were gathered. The final data component captures extreme crisis events occurring around the United States. To obtain timing, location, and severity information about notable disasters we use the Federal Emergency Management Agency?s (FEMA) database of disaster declarations.[2]. There were 120 disaster declarations during our observation period.

3 Methods: Topic Models and Topic Identification

Our first goal in this research is to characterize the information space of online communication by our sample of emergency management-related organizations. Analysis of large-scale text corpora is a growing research topic. Here, we use topic models to understand and group the prominent themes within the set of government agency tweets (Hofmann, 1999; Blei et al., 2003). Specifically, we use Latent Dirichlet Allocation (Blei et al., 2003), implemented using the `topicmodels` package in the **R** statistical computing language (Grn and Hornik, 2011). For a given document, LDA assumes that the document arises as a mixture of a finite set of "topics" or general themes. Topics then are defined as distributions over words. In our case, we use the weights associated with each topic to understand the information function of each tweet.

In our analysis, we fit a single model to the entire corpus, then generate

[1] `http://heroicproject.org/`

[2] https://www.fema.gov/disasters/grid/year

results for specific actors or time periods using draws from the posterior predictive distribution. This approach learns the overall topic structure using all available data, then produces the mapping of that topic structure onto specific periods of time or accounts. We can then compare accounts and time periods by comparing the posterior predictive distribution over topics.

We fit topic models using the `LDA` command with Gibbs sampling in the `topicmodels` package (Grn and Hornik, 2011). We will present results with 15 topics, which represents a diverse set of informational topics, while still being relatively internally coherent. Using these probable words, we next assigned thematic titles to each topic, which qualitatively capture the prominent theme within each topic.

Considering the top words per topic provides some initial face validity that each topic is relatively internally coherent. Moreover, while some topics address facets of similar themes - "Severe Storm" and "Severe Weather," for instance - the topics also appear to be distinct. All subsequent analysis of individual behavioral patterns uses the 15-topic model to predict the distribution of these topics for by Twitter account; in other words, these 15 topics are the bases by which all subsequent actor similarities, differences and distinctions are uncovered.

4 Preliminary Results

Our focus here is to characterize the communication practices of organizational actors within the emergency preparedness and response system in the United States. We explore the association between information behaviors (i.e., content produced) and functional designations within the disaster management ecosystem. Here, we demonstrate that similarity in terms of average content posted on Twitter seems to map to similarity in terms of functional role in response and recovery processes. However, we also show that everyday information behaviors differ from behavior during crisis periods, where entities local to the disaster itself tend to converge onto a mutual position within the information space; these event-driven roles significantly differ in terms of topical content.

Our second aim is to explore the ways in which information and communication behavior differs based on context, that is: how do routine, everyday situations compare with periods of crisis? First, we examine differences in content between tweets posted on days when at least one Federal disaster

declaration was made versus tweets posted on days containing no declarations. We identify several topical shifts between non-event and event days; we see a clear increase in response and recovery related topics, while preparedness topics are shown to decrease in occurrence. These patterns reveal evidence of convergence towards event-oriented content when extreme events occur, even emergency responders of all types, both directly and indirectly affected, are more likely to tweet similar information.

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