

SUPER: Towards the use of Social Sensors for Security Assessments and Proactive Management of Emergencies

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ABSTRACT

Social media statistics during recent disasters (e.g. the 20 million tweets relating to ‘Sandy’ storm and the sharing of related photos in Instagram at a rate of 10/sec) suggest that the understanding and management of real-world events by civil protection and law enforcement agencies could benefit from the effective blending of social media information into their resilience processes. In this paper, we argue that despite the widespread use of social media in various domains (e.g. marketing/branding/finance), there is still no easy, standardized and effective way to leverage different social media streams – also referred to as *social sensors* – in security/emergency management applications. We also describe the EU FP7 project SUPER (Social sensors for security assessments and Proactive Emergencies management), started in 2014, which aims to tackle this technology gap.

1. INTRODUCTION

Social networks and social media are among the most prominent technologies of our time [2], which already play a significant role in our society. Indeed, we are nowadays witnessing the rapid proliferation of social media infrastructures, which is accompanied by a steady increase in the number of the individuals that participate and use them [6]. On the basis of users’ participation, social media provide a wealth of information, which, if analyzed properly, has the potential of providing millions of insights on people’s attitudes and behavior [1].

Acknowledging this potential, experts from divergent disciplines (such as social scientists, political scientists [20], financial analysts [5], branding experts [22] and market researchers [7]) have recently been using social media as a source of data towards explaining human behavior in the physical world. Applications in these areas are empowered by innovative developments in the area of social media processing, such as topic tracking [10] and sentiment analysis [3]. In addition to behavioral analysis, social media is also

currently used for real-time detection of events, based on recent advances in fast and scalable hashing algorithms [12]. Furthermore, the fact that more and more users are participating within social networks, makes social media platforms ever more effective tools for communicating with individuals and communities.

However, despite the widespread use of social media in various domains (as outlined above), its use in the scope of security and/or emergency management applications is still in its infancy. Although some early applications have been reported (e.g. Twitter analysis for real-time identification of earthquakes in [16]), there is still no easy, structured and well-defined way to leverage several social media streams in the scope of tools for security and/or emergencies management. As a result, security forces and civil protection agencies cannot exploit and fully leverage the capabilities of the proliferating social media infrastructures to make security assessments of events, or conduct proactive incidence response. We argue that this is a lost opportunity, which is becoming even more significant due to the extensive use of social media in the scope of security-relevant and/or emergency situations.

SUPER (Social sensors for security assessments and Proactive Emergencies management) is a new project funded by the European Commission within the 7th framework programme. SUPER explores a holistic integrated framework for tracking and evaluating the reactions of different types of stakeholders (e.g. victims, volunteers, citizens) to emergencies using social media, while at the same time empowering security forces and civil protection agencies to fully leverage social media in their operations. It involves researchers from National Technical University of Athens, the University of Glasgow and Barcelona Media/Yahoo! Research, as well as security and sensing companies Sensap, Vitrociset and IN2.

Importantly, SUPER also engages a number of end-user organizations concerned with emergency management, in particular, the Romanian Police and the Civil Protection Service of Campania Region of Italy contribute to the project as partners, in addition to a further 7 end-user organizations with advisory roles. Such end-user organizations offer insights into the current challenges brought by social media to the management of real-world emergency scenarios. In this paper, we describe the requirements elicited from end-user organizations to address these challenges, as well as the components of the SUPER project that can address such requirements. In doing so, this paper contributes a discussion on social media analytics requirements and challenges faced

by emergency response agencies – which we believe are of interest to other social media analytics researchers – as well as potential solutions proposed by the SUPER project.

The remainder of this paper is structured as follows: Section 2 discusses the requirements identified for emergency management elicited from end-user organizations; Section 3 discusses the primary functionalities identified within the framework proposed by the SUPER consortium as solutions towards those requirements. Concluding remarks follow in Section 4.

2. END-USER REQUIREMENTS

Social sensors allow the detection and tracking of real-world events, through their real-time reporting and discussion within social networks. For instance, earthquakes can be identified automatically through the Twitter social network [16]. Indeed, it has been shown that newsworthy events can be detected faster using social media than reporting in traditional media outlets for some types of event [13]. Moreover, live information from social sensors can be highly valuable for tracking how events evolve over time, and analyzing public opinions about entities and events [14].

In contrast, SUPER is focused upon security and emergency response situations, particularly those aligned with the end-user partner organizations, such as flooding events or rioting. Such emergency and security response situations exhibit particular stages where social media can be useful: *mitigation* - preventing of an event; *preparedness* - rehearsing for expected events; *response & recovery* - understanding and managing events as they happen.

For instance, real-time event detection and behavioral analysis can be used to successfully coordinate operations associated with the handling of security and/or emergency events, e.g. using people’s reactions during a specific event in order to coordinate crowd management and evacuation operations; The coordination of these operations can be also facilitated from the use of social media as a sensor. Moreover, at the higher strategic level, leading officers can exploit knowledge about people’s attitudes against (or during) security incidents identified within social media, with a view to planning operations, better responding to public sentiments and to support information gathering processes in general.

However, one of the key observations that emerged from the feedback elicited from the SUPER end-user organizations was that government agencies are increasingly looking towards social media as a medium that they can use to actively reduce the impact of an event, rather than simply monitor it. For example, this could take the form of reducing the number of casualties by better informing the populous in real-time, identify vulnerable social groups that might suffer from conditions such as post-traumatic stress as a result of the event or collect feedback on end-users’ actions in the field. Indeed, one of the goals of SUPER is to explore social media as a unilateral/bilateral communication medium, in addition to leveraging social media to monitor events.

Based on the feedback received from SUPER end-user organizations, the major requirements of an emergency management system that can leverage social media are:

- R1 To process social media streams in order to detect and follow/search for events of interest (e.g. emergencies) and support the agencies’ communication strategy.
- R2 To gather the opinions of citizens posted through social

media and to identify whether the collected information is trustworthy or a rumor.

- R3 To identify different sub-groups in crowds, e.g. classify users in predefined emergency related categories (volunteers, victims etc).
- R4 To facilitate the bilateral communication between end-user agencies and public, the coordination among agencies involved in emergency management and an informed management approach.

How these requirements are met by technical components will be explained in Section 3. Of course, monitoring of social media has legal/privacy/ethical dimensions which leads to a final important requirement:

- R5 SUPER social sensors should enhance and complement the existing protocols of security assessment and emergency management in compliance with the national and European legal frameworks.

Therefore, through the four primary requirements identified above, and within the legal context identified within R5, it is clear that the surveyed end-user organization can foresee a clear role for social media analytics and interaction during emergency response scenarios.

3. ARCHITECTURAL COMPONENTS FOR SUPER

To tackle the requirements described in the previous section, it is envisaged that the SUPER architecture will comprise of multiple components, each providing a valuable functionality to the end user, which we summarize below:

Event Detection (R1): To address requirement R1 identified above, the SUPER platform will process data streams from online media in order to track events that might be of interest to end-user scenarios, and thereby aid in the response & recovery of events. The topics of interest, based on which the events will be identified will be defined by the end-users and can change dynamically. In the framework of SUPER, several alternative approaches will be explored for event detection. One approach will be to identify events by analyzing streams of posts (both text and metadata) in social media platforms such as Twitter [12], while an alternative approach will extend [19] using Wikipedia as a source for event detection and monitoring. The results will be contrasted with [8] and [13].

Event Summarization (R1): In addition to identifying new events, within the context of requirement R1, SUPER will address the issue of tracking sub-events with respect to a large event. For instance, when a disaster occurs, such as the helicopter crash in London,¹ it would be important to concisely report what is happening on the ground. For instance, responders would want to know when the event occurred and how many people were injured. This can be seen as a summarization task, where the aim is to produce a topical, high-quality timeline of novel updates about a larger event in a timely manner [11].

Behavior and Sentiment Analysis (R2): The SUPER platform will provide mechanisms for analyzing behavior

¹en.wikipedia.org/wiki/Vauxhall_helicopter_crash

patterns over time in social media in the context of emergencies. Models for individual and collective behavior in this setting will allow for immediate understanding of online social dynamics around an event in real time. In addition, SUPER will also combine and extend algorithms ([4, 18]) for sentiment analysis, such that the sentiment dimensions of authors of social media posts can be determined. This will help end-users evaluate the reaction of citizens to the emergency management procedures.

Rumor Identification and Credibility Analysis (R2): SUPER will also help end-users evaluate the trustworthiness of online content by providing functionality to identify unverified rumors and misinformation within social media content that the public might believe and/or act upon. SUPER will also provide tools to aid the tracking of those rumors over time. More specifically, building upon [15], the rumor detection framework of SUPER will deal with automatic identification of social media posts as relating to a rumor; the linking together of posts with respect to previously identified rumors; and the ranking of posts about a rumor based upon their trustworthiness/credibility.

Community Detection (R3): To effectively leverage social media, it is important to understand the users of that medium and their motivations. The SUPER platform will analyze posts in social media posts related to topics defined by the end-users and based on those will classify users in pre-defined scenario-specific communities. The topic community detection functionality will be event-based (i.e. community classification will triggered by events detected by the event detection component). In addition to that, we will also track the evolution of communities over time. Finally, the results of topic community detection will be combined with the results of rumor detection in order to examine rumors with regard to bias within communities.

Integrated Search (R1): Additionally, making use of the Terrier search engine platform [9], SUPER will provide dynamic indexing and retrieval of content across different types of social media data generated by the above SUPER components, e.g. rumors, or sentiment. In this way, SUPER will facilitate information exploration and discovery by SUPER end-users during the event, as well as after the event, to facilitate preparedness and mitigation activities for future similar events.

Interaction with Social Media (R4): In addition to getting an insight of the citizens' reactions and disposition by analyzing their online activities through the social sensors, the end users will have direct access to multiple social media platforms. SUPER will provide them with tools for seamlessly searching for online content from different sources in real time. A two-way interaction between the SUPER and the different platforms is foreseen, that will allow end-users to post emergency related information on dedicated social media accounts and prioritize social media discussion threads according to visibility and credibility (e.g. discrediting of highly visible rumors), thereby facilitating the proactive management of events through social media platforms.

Common Operational Picture (R4): Given the large number of technologies underpinning SUPER, the platform requires a modular user interface design that will enable end-users to discover, explore and organize the social media con-

tent surfaced by these technologies in parallel to leveraging current collaboration and control technologies currently used by disaster management agencies. Indeed, SUPER needs to support user interaction in a variety of briefing, debriefing or decision support scenarios. SUPER builds upon the C2HMI (Command and Control Human Machine Interface) [21] interface platform, which supports simultaneous multi-touch interaction in a web environment, as well as integrating collaborative platforms that can be used concurrently by multiple end-users.

The SUPER social sensors will work with user generated content collected from social networks. In order to enable their functionality, the platform will support the real time access to streams of social media posts. Data will be collected from social networks based on end user defined specifications (i.e. keywords, location) by leveraging the streaming functionality of social networking APIs. In addition, it will also be possible for the social sensors to gather additional information on a post or user (e.g. profile information or graph) by performing dedicated API calls to the underlying social media platform.

Of course, within the complex multi-level legal environment suggested by R5, where countries implementation of EU privacy directives may vary, any project must involve legal, ethical & privacy specialists to ensure that compliance with appropriate laws and ethical standards are maintained.

4. CONCLUSIONS

In this paper, we introduced the SUPER (Social sensors for security assessments and Proactive Emergencies management) project, that aims to develop technologies to aid in the real-time management of emergencies using social media. In particular, we argued that leveraging social media can provide tangible benefits during emergency and security response situations and discussed how this might be achieved in terms of event mitigation, increasing preparedness and during response & recovery – based on feedback from real emergency-response organizations. Finally, we highlighted key technologies that will be investigated within SUPER.

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