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Accident monitoring framework based on online social network sensing

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Abstract

Social sensing is increasingly becoming a viable addition to the urban monitoring toolkit for practitioners and decision-makers. It seems to be more flexible and cost-effective as compared to dedicated monitoring systems based on instrumental sensors and surveillance cameras. However, benefitting from these advantages requires deploying fine-tuned approaches to work with rich and voluminous data generated by volunteers or users of social network sites. In this paper, we consider the issue of processing unstructured, distorted and fragmentary textual data produced by the members of the community aimed at sharing experiences and observations of accidents and unusual experiences with the urban environment. We propose a solution that allows aggregating unstructured and noisy user reports and extracting valuable information from them. This solution is based on recurrent neural networks and represents a framework handling the whole of the process starting from data collecting to classifying extracted information.

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Keywords: online social networks; social sensing; recurrent neural networks; semantic parsing

1 Introduction

Modern cities witness numerous events daily, some of which are accidents and critical situations that may pose a threat to residents and guests at different time scales. Successful management of modern big cities thus requires several advanced instruments which include monitoring, analytical and decision support systems. Monitoring systems are especially crucial as other tools process data they provide to assess the state of the city, develop a solution to prevent undesirable situations or plan recovery and control its implementation.

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There are few ways to implement a monitoring system that vary regarding the goals followed, resources they require to deploy successfully and data it can provide. Deployment of a hardwired, dedicated monitoring system, consisting of specifically fixed detectors is usually the most reliable long-term solution, best suitable for tracking urgent situations such as floods, terrorist attacks, and, at the same time - the most expensive. Such systems may be affordable only for a small subset of very important areas or structures of a city. At the same time, there are other kinds of goals such as assessment of city services quality or operative monitoring for minor accidents. For these goals, it may turn out to be expensive and/or time costly to deploy dedicated monitoring infrastructure or perform monitoring by means of human agents. Moreover, such systems are generally quite inflexible. As the outline and the structure of the city are changing, these may require additional upgrades and adjustments. But the required data nevertheless can be obtained using techniques of social sensing. These techniques assume using content generated by users of online social networks, public sites and analogous domains to infer from the knowledge about the current state of the urban environment. In comparison to dedicated monitoring systems, social sensing platforms provide a number of almost unparalleled features. First, these systems can help assess traces of routine experiences of the urban space users, which are different from involvement into critical/hazardous/exceptional situations which is a primary focus of the rigid monitoring systems. Motivation for systematically analysing everyday experience can be justified from the position of public health (e.g. minimization of non-critical ambient stressors that can bring destructive health outcomes over time), law enforcement (minor flaws in urban environment can trigger further intentional violations of its integrity) and urban development (assessing the state of the city and its parts can inform programs aimed at evaluating the living conditions).

To utilize the capacities for monitoring social sensing provides, one needs to have a proper approach to deal with certain restrictions imposed by the regulations of social networks and informal (and mainly unobserved) communicative rules. In the first place, social networks and other similar entities are designed for a large audience of users and their data is provided in an unstructured form, often as a text written in a simplified and distorted natural language. Such a form yet still contains a location description with name of streets and places, sometimes bearing informal, linguistic variables (for example, such words and phrases as nearby, not far away, etc., which meaning can be statistically inferred in the form of probabilistic distribution) instead of explicit and structured geographical coordinates which are provided by the networks as a feature which is ‘ready-to-use’. Thus, any monitoring systems that deals with data displayed this way needs to have the capacity to process these texts, extract facts and relations and interpret them.

All the features mentioned above require deep knowledge of natural language processing, text preprocessing, online social networks data collection and machine learning. In its own turn, it makes hard for a practitioner to get advantages of using such content which is available in public sources on the internet. From the other point, existing systems which deal with online social networks and other publicly available source of social sensing information, provide only limited capability converging to searching text posts by certain predefined topics with keywords.

In this paper, an approach is proposed to deal with this problem for the road, and emergency situations in modern cities are basing on social media information and tested on Vkontakte online social network and its public group “ДТП и ЧП” ("Road Accidents and Emergencies").

Main contributions of this work are the following:

- an approach, implemented in the form of a framework, for extraction of facts and relations about certain types of road and emergency accidents from social media has been developed.
- an experimental study of the proposed approach and framework for Russian language and Russian online social network Vkontakte has been carried out.

2 Related works

Social sensing techniques dealing with unstructured, user-generated data rely heavily on natural language processing methods. A significant effort has been put by the scientific community into solving named entity recognition problems [6 - 13]. These works are dedicated to extraction of special type of entities that stand out of the rest of the text through exhibiting relations to certain objects or events. Since working with structures and meanings in the text is language-specific, there is a steadily increasing number of papers dedicated specifically to developing algorithms for Russian language. Despite the high quality of such extractors, they are not suitable for extraction of general entities

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