SAVIZ: Interactive Exploration and Visualization of Situation Labeling Classifiers over Crisis Social Media Data

Mayank Kejriwal
Information Sciences Institute
University of Southern California
Marina del Rey, CA
kejriwal@isi.edu

Peilin Zhou
Information Sciences Institute
University of Southern California
Marina del Rey, CA
zpeilin@isi.edu

Abstract—Due to climate change and the effects of geopolitical and social challenges like the refugee crisis in Europe, the world is facing an unprecedented set of humanitarian problems. According to the United Nations, there is a projected funding shortfall of more than 20 billion dollars in addressing these needs. Technology can play a vital role in mitigating this burden, especially with the advent of real-time social media and advances in areas like Natural Language Processing and machine learning. An important problem addressed by machine learning in current crisis informatics platforms is situation labeling, which can be intuitively defined as semi-automatically assigning one or more actionable labels (such as food, medicine or water) to tweets or documents from a controlled vocabulary. Despite multiple advances, current situation labeling systems are noisy and do not generalize very well to arbitrary crisis data. Consequently, consumers of these outputs (which include humanitarian responders) are unwilling to trust these outputs without due diligence or provenance. In this paper, we demonstrate an interactive visualization platform called SAVIZ that provides non-technical first responders with such capabilities. SAVIZ is completely built using open-source technologies, can be rendered on a web browser and is backward-compatible with several pre-existing crisis intelligence platforms. We use two real-world scenarios (the 2015 earthquake in Nepal, and the unfolding Ebola crisis in Africa) to illustrate the potential of SAVIZ.

Index Terms—Situational awareness, visualization, embeddings, crisis informatics

I. INTRODUCTION

The United Nations Office for the Coordination of Human Affairs (OCHA) reported that in 2016, more than a hundred million people were affected by natural disasters alone, while over sixty million people were forcibly displaced by violence and conflict. Consequently, crisis informatics has emerged as an important interdisciplinary area, with contributions from both social and computational sciences, including machine learning, information retrieval, natural language processing, social networks and visualization.

To realize this vision in more specific ways, multiple government and private programs have been instituted. For example, the DARPA LORELEI program was established with the explicit agenda of providing situational awareness for emergent incidents, under the assumption that the emergent incident occurs in a region of the world where the predominant language is computationally low-resource. An example is Uighur, a Turkic language spoken by about 10-25 million people in Western China, for which few automated technology capabilities currently exist. LORELEI situational awareness systems like THOR must first translate tweets and messages into English, using automated machine translation algorithms, and to provide further analytical capabilities, must execute additional Natural Language Processing (NLP) algorithms like named entity recognition, automatic detection of need types (e.g., does the tweet express a food need or a medical need?) and sentiment analysis.

Despite advances in NLP and AI, such algorithms continue to be noisy. For example, we executed a state-of-the-art crisis informatics NLP system called ELISA on an Ebola dataset collected over Twitter. Among other things, ELISA ingests a tweet as input and uses a pre-trained machine learning module developed over the course of the ongoing DARPA LORELEI program to output categorical situation labels such as food, medicine, water and infrastructure that allow humanitarian responders to quickly decide where to focus their attention and resources (as opposed to reading every single tweet in the corpus). While for some (pre-processed) tweets such as ‘ebola in sierra leone’, ELISA correctly outputs the label ‘med’, it also erroneously outputs labels like ‘med’ for other


Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than ACM must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from permissions@acm.org.

ASONAM ’19, August 27–30, 2019, Vancouver, Canada
© 2019 Association for Computing Machinery.
ACM ISBN 978-1-4503-6868-1/19/08...
http://dx.doi.org/10.1145/3341161.3343703


Ebola is a rare and deadly disease that currently has no approved vaccine or cure: https://www.cdc.gov/vhf/ebola/index.html
tweets like ‘vivian dou yemm moh’, which have become meaningless due to mangled machine translation or heavy dependence on emoticons and symbols (that get removed during pre-processing). While the modules get better over time, performance is still well below 70% F-measure due to data sparsity and noise. Performance is even worse when the modules are trained on one type of disaster or locale, but have to be applied in another. This is a pervasive problem in crisis informatics, since every crisis is different, making generalization difficult. It also makes humanitarian responders question the veracity of such a system, making transition and uptake of advanced AI technology a social challenge.

In this demonstration, we present a highly lightweight, interactive visualization platform called SAVIZ that can be deployed on a web browser in less than 30 seconds for thousands of tweets, and is designed for short, crisis-specific messages collected over social media like Twitter, and processed by systems like ELISA. SAVIZ relies on established, pre-existing and open-source technologies from the representation learning, visualization and data processing communities. SAVIZ is backward-compatible with crisis informatics sub-systems recently released under the LORELEI program, and has been applied on real-world datasets collected from the Twitter API. Users will be allowed to play with these datasets using SAVIZ.

II. SYSTEM

SAVIZ has a simple processing workflow that is illustrated schematically in Figure 1. As a first step, the system ingests an input Twitter corpus that has been collected in the aftermath of a crisis. A good system that is capable of such focused data collection is CrisisLex [6]; also, the recent pipeline approach by Gu and Kejriwal is an alternative way of collecting relevant tweets using methods like active learning [7]. Once the corpus has been collected, a situational awareness system like ELISA [5] is typically executed over it. However, generic black-box algorithms from the sentiment analysis and classification literature could also be used in this phase. The result of such analysis is one or more categorical labels per tweet.

The next few steps are unsupervised. The tweets are first preprocessed by converting them to lower-case and removing special symbols and characters (like #, @ etc.), along with tabs and newlines. For example, the tweet ‘massive earthquake in NEPAL ———————————— Bhimsen Tower aka Dharahara In Nepal.... http://t.co/4tUDQDWvCc’ would, after preprocessing, become ‘massive earthquake in nepal bhimsen tower aka dharahara in nepal httpco4tudqdwc4’.

Next, we use the ‘bag-of-tricks’ word embedding package (called fastText [8]) released by Facebook Research to embed the words and sentences into a dense, continuous and low-dimensional (specifically, 100-dimensional) vector space. To enable visualization, we use t-SNE [9] to project the sentence vectors into a 2D space. All of this information, including the categorical labels output by systems like ELISA, are compiled into a NoSQL file which is input to the SAVIZ visualization system. The visualization is based on Bokeh, an interactive, well-documented visualization library that targets modern web browsers for presentation. Bokeh aims to provide elegant, concise construction of versatile graphics, and to extend this capability with high-performance interactivity over very large or streaming datasets. Because it uses Bokeh, SAVIZ requires no extensive set up, since the visualization itself is rendered on a web browser, making the system portable.

A. User Experience

We demonstrate the simplicity of using, and the key features of, the system for a complex disaster (the Ebola crisis) that is still unfolding in Africa. Figure 2 illustrates the SAVIZ interface for an Ebola dataset that was collected from Twitter. The full corpus that we collected, using Ebola-specific keywords, comprises 18,224 tweets, with timestamps ranging from 2014-Aug-01 00:03 to 2014-Sep-24 23:16. ELISA [5] was executed on this corpus, yielding zero or more situation labels per tweet from a vocabulary of eleven types: food, infrastructure, water, utilities, regime-change, terrorism, medicine, evacuation, shelter, search, and crime/violence. These labels could be noisy; no ground truth was available against which the accuracy of ELISA on the situation labeling task could be ascertained. For visualization purposes (Figure 2), we sampled 720 points from this corpus with timestamps ranging from 2014-Aug-01 00:03 to 2014-Sep-24 23:16, and over five common types (infrastructure, water, search, medicine, and food).

In the demonstration, we will allow the user to play with this dataset and interface, including facet selection and de-selection, and interaction with points (including drawing of
Fig. 2: The SAVIZ interface over an Ebola dataset collected over Twitter. The tabular view can be re-generated, and made more focused, by drawing a bounding box around any portion of the screen.

Bounding boxes around points). Furthermore, as evidence that the system works for arbitrary disasters, we also consider a second disaster, namely the earthquake in Nepal in 2015. This corpus was also collected over Twitter and consists of 29,946 points, with timestamps ranging from 2015-Apr-25 01:00 to 2015-May-06 09:42. Once again, ELISA was executed over this corpus to yield zero or more situation labels from a vocabulary of seven labels (utilities, water, food, medicine, shelter, search, and infrastructure). We present a visualization of the system for the Nepal disaster in Figure 3. For visualization purposes, we considered a sample of 1,810 tweets, with timestamps ranging from 2015-Apr-25 01:00 to 2015-May-02 06:56, and over five common types (food, medicine, shelter, infrastructure and search).

B. Infrastructure Requirements

The infrastructure requirements of this demonstration will be minimal: the technology underpinning the demonstration will be running on our machine as a local instance and will not even require an Internet connection. Typical demonstration experiences are expected to last 1-3 minutes, and designed to accommodate a high number of attendees. If possible, to display the demonstration on a bigger screen, we request a larger display that can be connected to our laptops. Finally, we will also record a video briefly illustrating the key features of the system for those users who do not wish to interactively experience the system.

III. RELATED WORK

Visualization is an important part of any human-centric system that is attempting to make sense of a large amount of information. Several good crisis informatics platforms that provide visualizations include Ushahidi [10], Twitris [11], CrisisTracker [12], and several others. A more sophisticated system, THOR (Text-enabled Humanitarian Operations in Real-time), also provides sophisticated situational awareness [4], but is designed for computationally low-resource languages like Uighyr and Bengali, and consequently has a strong focus on machine translation and other NLP modules like Named Entity Recognition.

Several aspects of SAVIZ distinguish it from the systems referenced above. The most important difference is that, unlike the systems above, SAVIZ ingests not just the raw social media data stream itself, but the categorical outputs of NLP and machine learning systems like situation labeling and sentiment analysis [5]. Thus, SAVIZ allows the user to jointly explore both the social media data and the labels, which serves two purposes: to understand the noise in the classification system, and to understand the social media stream in aggregate. For example, consider again Figure 2 which expresses the (initially non-intuitive) finding that ‘water’ (green) is as big

6Slightly different versions of ELISA were available at the times of data collection; hence the vocabularies are different between Nepal and Ebola.
an issue in the context of the collected data, as ‘med’ (pink), which is what one would expect in a dataset collected from the Twitter API specifically using Ebola-related keywords. Other differences between SAVIZ and systems like CrisisTracker [12] is its use of embeddings and 2D projection (using t-SNE) as an interactive visual aid. As more advanced embeddings (including network and knowledge graph embeddings [13], [14]) continue to be developed and released as open-source, SAVIZ will be well-positioned to use these to provide an alternate ‘view’ of the data. The current version of SAVIZ is already capable of treating embeddings as a black-box, by directly ingesting the high-dimensional vectors as its input. This allows the system to be lightweight, simple and customizable.

IV. Future Work

While the primary purpose of SAVIZ is machine learning-powered social data exploration during a crisis, we are looking to extend its interactive capabilities to help users correct existing, and provide new, annotations directly using the interface. Currently, data annotation services are expensive and require sharing of data. They are also not real-time, even when using crowdsourcing (which may also incur quality issues due to lack of motivation and domain expertise). SAVIZ will place control firmly in the hands of the field users, who are best equipped to be both labeling and exploring the data.

Acknowledgements. The authors were supported under the DARPA LORELEI program.

REFERENCES


